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REPORTS
TO THE
LOCAL GOVERNMENT BOARD
ON
PUBLIC HEALTH AND MEDICAL
SUBJECTS.

(NEW SERIES NO. 56.)

Dr. F. J. H. Coutts' Report to the Local Government Board on an inquiry as to Condensed Milks; with special reference to their use as Infants' Foods.

[*Food Reports, No. 15.*]



LONDON:

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STATIONERY OFFICE

By JAS. TRUSCOTT AND SON, LTD., CANNON STREET, E.C.

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1911.

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TO THE RIGHT HONOURABLE JOHN BURNS,
M.P., PRESIDENT OF THE LOCAL GOVERN-
MENT BOARD.

SIR,

THIS report by Dr. Coutts, which I have the honour to present, forms one of a series of investigations undertaken by the Board with a view to adding to our knowledge of the means for promoting the hygiene of infancy and childhood.

Among the investigations and reports having this object in view may be mentioned the report by the Medical Officer of the Board on Infant and Child Mortality (Cd. 5263, July, 1910), dealing with the deaths and causes of death under five years of age in the administrative counties of England and Wales. This will be followed by a study of the incidence and causes of child mortality in our chief urban centres of population, and by other investigations.

The feeding of infants is one of the chief influences determining their prospects of survival and of health and efficiency in later life; and several inquiries instituted by the Board, including the one of which the results are now presented, will be concerned with this aspect of the hygiene of childhood. Of these, one will deal with the question of the composition of various infant foods, and the risks associated with their use, another with dried milk, which is coming increasingly into use. Another report will summarise experience in this and other countries of the use of sterilized cows' milk in the feeding of infants; and Dr. Jane Lane-Claypon, who has nearly completed this report, is also investigating experimentally for the Board the special biological characters believed to characterise fresh as distinguished from sterilized milk.

The present report by Dr. Coutts deals exhaustively with condensed milks, with special reference to their use as infants' foods.

Dr. Coutts has definitely ascertained that machine-skimmed condensed milk is used on a considerable scale for feeding infants, and he gives reasons which appear to point to the conclusion that this use is increasing. Infants are thus deprived of the fat which is essential for growth and health. There are serious drawbacks to the use, except as a temporary expedient, of full-cream sweetened condensed milk as an infants' food, the most objectionable

feature being the presence of excess of sugar in relation to other food elements; but the use of skimmed condensed milk for the same purpose implies a slow process of partial starvation. Full-cream unsweetened condensed milk appears to be a suitable substitute, when required, for fresh cows' milk. The fact that it keeps less well than the sweetened variety is perhaps an additional safeguard, as it results in such milk being exposed for a shorter time to domestic contamination.

The experimental investigations by Drs. Gordon and Elmslie, given on pages 56 to 62, show that certain micro-organisms may survive the condensing process. All the epidemiological evidence points to the conclusion, however, that the infecting organisms of such diseases as scarlet fever, diphtheria, and enteric fever are destroyed in condensed milk. Direct experiments were carried out by Professor Delépine for the Board on milk which was artificially infected with tubercle bacilli, and subsequently condensed by one of the ordinary trade processes for this purpose. These experiments showed that under the conditions of the particular factory, the tubercle bacilli were destroyed by the condensing process. (These experiments will be published at an early date, along with a report on similar experiments in regard to dried milk and milk powder.)

It has to be remembered that although condensed milk is bacteriologically purer than fresh cows' milk, its liability to contamination after the tin is opened makes it a dangerous food for infants during the summer months. This is aided perhaps by the lowered condition of nutrition associated with the continued use of a food which is commonly deficient in fat and contains excessive sugar. There is abundant evidence that babies fed on condensed milk suffer in a much higher proportion from epidemic diarrhoea than do babies fed on fresh cows' milk, and still more than babies who are breast-fed (see p. 38).

The increased risk of acute illness is not the only danger associated with the giving of condensed milk to babies. Perhaps even more serious than this is the increased tendency to rickets. There is ample evidence to show that the malnutrition caused by feeding babies on skimmed condensed milk produces a large excess of rickets; and there is no doubt that babies fed on full-cream condensed milk suffer from rickets to a greater extent than do babies who are breast-fed, and probably more than babies fed on fresh cows' milk containing its full proportion of cream.

The importance of rickets as a cause of other diseases as well as deformities in childhood and in after-life is insufficiently understood.

Representations have been made to the Board by resolutions of Conferences on Infant Mortality and from Sanitary Authorities and other public bodies, to the effect that control should be exercised over articles supplied as food for infants, including condensed milk in its various forms; and in particular it has been urged that all tins of skimmed condensed milk should be required to bear on the labels a distinct warning that the contents are unfit for the food of infants.

These and other suggestions for the administrative control of the sale of condensed milk for the food of infants are discussed fully in Dr. Coutts' report, who confirms the most important of these recommendations as to the desirability of labelling all tins of condensed skimmed milk as being unfit for the food of infants.

I am, Sir,

Your Obedient Servant,

ARTHUR NEWSHOLME,

Medical Officer of the Board.

August, 1911.

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Dr. F. J. H. Coutts' Report to the Local Government Board on an inquiry as to Condensed Milks; with special reference to their use as Infants' Foods.

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I.—CONDENSED MILK: HISTORY AND METHODS OF PREPARATION.

HISTORY OF CONDENSED MILK.

As early as the 18th century Appert had devised a process for condensing milk by evaporation in air, but it was not successful. The invention of a practicable method of preparing condensed milk is attributed to Mr. Gail Borden, of White Plains, New York, who acting on a suggestion made, in 1849, by Professor Horsford, of Boston, successfully tried evaporation at a low temperature under reduced pressure; Borden obtained a patent for his process in 1856.

During the American Civil War large quantities of milk condensed by this process and packed in hermetically sealed tins were supplied for the Northern armies. Mr. Charles Page, correspondent for the "New York Tribune" during the war, was struck by the possibilities of the new method of preserving milk. At the close of the war he became resident in Switzerland as the United States Consul; in 1865, he and his brother started a small factory at Cham and originated the Anglo-Swiss Condensed Milk Company. Since then factories have been established in England, Ireland, Denmark, Norway, Bavaria, Holland, France, Austria, Italy and elsewhere.

From the first a certain amount of condensed unsweetened milk was made, but the article chiefly sold was derived from milk containing all its cream and sweetened by the addition of sugar. Later, some of the manufacturers began to skim the milk to a slight degree before condensing. The skimming process was carried out more and more completely until at last, a little over twenty years ago, some of the condensed milk sold in this country was found to contain only 0.53 per cent. of fat, having been made from machine separated milk. The introduction of this commodity and its sale without adequate declaration presently led to the insertion in the Sale of Food and Drugs Act, 1899 (Sections I. and XI.), of provisions requiring all condensed separated or skimmed milk imported into this country, and all such milk sold or exposed for sale, to bear on the tin or other receptacle a label on which the words "Machine Skimmed Milk" or "Skimmed Milk" as the case may require, are printed in large and legible type. This requirement has resulted in the virtual disappearance of condensed partly skimmed milk, the manufacturer finding it more profitable either to supply the full cream variety or to extract the fat by mechanical means as completely as possible and to sell the product as machine skimmed condensed milk.

VARIETIES OF CONDENSED MILK.

1. *Full Cream.*

- (a.) Fully sweetened by the addition of 35-40 per cent. of cane sugar.*
- (b.) Partially sweetened by the addition of sugar in small amounts, *e.g.*, 2-3 per cent. or 10-12 per cent.; in all cases below 18 per cent.†
- (c.) Unsweetened.

2. *Machine Skimmed.*

- (d.) Fully sweetened; *e.g.*, by the addition of 38-45 per cent. of cane sugar;
- (e.) Partially sweetened; *i.e.*, below 18 per cent. of sugar;
- (f.) Unsweetened.

I have not been able to get direct evidence that the two last-named varieties are actually on the market at the present time. A sample of a consignment purporting to be partially sweetened machine skimmed milk (e) was found to consist of slightly sweetened full cream milk. I have no evidence that fully skimmed unsweetened condensed milk (f) has ever been manufactured on a large scale, but some years ago a sample of unsweetened condensed milk offered for sale to dairymen for mixing with fresh milk was found on analysis at the Government Laboratory to have been made from partially skimmed milk.

Besides the articles commonly known as condensed milk, various other forms of preserved milk are manufactured, *e.g.*, "Natural Milk, Homogenised and Sterilised"; "Unsweetened Sterilised Evaporated Milk," (which is milk condensed to a smaller extent than usual), and Milk Powder or Dried Milk which may be made from full cream, partially skimmed or machine skimmed milk, and either with or without added sugar. Recently it has been held by a Court of Petty Sessions that dried milk comes under the heading of condensed milk, in so far as the provisions of section 1 of the Sale of Food and Drugs Acts, 1899, are concerned.

* By the term "cane sugar" chemists frequently denote "sucrose" from any source; for convenience it is used in this sense throughout this report. The "cane sugar" employed in the manufacture of condensed milk is probably always derived from beet.

† The import list of H.M. Board of Customs and Excise, 1910, includes the following classification of condensed milk:—

Milk condensed, not sweetened;

Milk condensed:—

Sweetened, whole;

Sweetened, separated or skimmed;

Slightly sweetened, whether whole, separated or skimmed if declared by the importer not to contain more than 18 per cent. of added sugar, subject to occasional sampling and testing.

Unsweetened condensed milk is admitted duty free. Duty is charged (1910) on sweetened milks at the following rates—

Condensed sweetened full cream milk, 9*d.* per cwt.

Condensed sweetened separated or skimmed, 10*d.* per cwt.

Slightly sweetened, whole, separated, or skimmed, 4*d.* per cwt.

PROPORTION OF VARIOUS KINDS OF CONDENSED MILK PREPARED
ABROAD AND MADE AT HOME.

(a.) *Importation.*

The following figures extracted from the Annual Statements of the trade of the United Kingdom with foreign countries and British possessions, compiled in the Statistical Office of the Customs and Excise Department, give an idea of the quantities of imported condensed milk. Since 1902 sweetened "full cream" and "machine skimmed" have been differentiated; previously one heading included all varieties.

Imports into the United Kingdom of Condensed Milk in Cwts.

						Cwts.
1895	...	...	...	...	...	545,394
1896	...	...	...	...	...	611,335
1897	...	...	...	...	...	756,234
1898	...	...	...	...	...	817,274
1899	...	...	...	...	...	824,599
1900	...	...	...	...	...	987,003
1901	...	...	...	...	...	919,319

From 1902 to 1909 importations were as follows:—

Year.	Separated or skimmed— sweetened.	Full cream sweetened.	Full cream or skimmed slightly sweetened.	Condensed milk not sweetened.	Total.
	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
1902 ...	307,984	554,389	5,754	46,548	914,675
1903 ...	323,877	547,567	3,020	41,253	915,717
1904 ...	365,543	497,551	1,248	39,794	904,136
1905 ...	374,560	483,960	1,170	33,944	893,634
1906 ...	458,675	421,180	3,052	25,076	907,983
1907 ...	458,980	428,936	1,228	22,627	911,771
1908 ...	475,108	407,690	1,019	36,393	920,210
1909 ...	507,304	436,035	370	47,669	991,378

(b.) *Manufacture in the United Kingdom.*

The manufacture of condensed milk in the United Kingdom was commenced over 30 years ago, and now there are nine or ten factories in England, and as many in Ireland engaged in this industry. Two large firms own the majority of these factories, but there are other smaller firms engaged in the business. Full cream, sweetened and unsweetened, and machine skimmed varieties are made, but no reliable figures are available to show the total or the relative amounts of each. Perhaps it would not be far wrong to estimate the proportion of machine skimmed at about one-half the total. The Irish factories make chiefly machine skimmed condensed milk, whilst the principal English factories make only the full cream variety. A considerable portion of the full cream milk manufactured in England is exported to British

Colonies and foreign countries, whilst most of the Irish-made machine-skimmed milk is utilised for home consumption.

Of late years a considerable number of persons have taken up the manufacture of dried milk in England, but not apparently on a very large scale.

As regards condensed milk from all sources it appears that in recent years the amount of machine skimmed condensed milk used in this country has steadily increased, whereas the use of full cream milk has diminished.

METHODS OF PREPARATION.

Full Cream Milk.

The details of manufacture vary in different factories, but a general idea of the process as usually carried out may be obtained from the following description. Fresh milk brought to the factory is weighed after being strained through a fine sieve; it is then pasteurised by heating to 80° - 85° C. or even higher. Cane sugar in the proportion of $13\frac{3}{4}$ to 15 per cent. on the weight of the milk is added. This may be mixed in powder form with the hot milk or may be dissolved separately in a small amount of hot water and added gradually to the milk during the filling of the vacuum pan. The vacuum pans are large copper vessels with a capacity of 1,000 to 3,000 gallons; they are provided with coils of copper steam pipes at the bottom and are connected at the top to powerful suction pumps. After the mixture of milk and sugar has been introduced into the vacuum pan the milk is boiled under reduced pressure at a temperature of about 50° C. for two to three hours, the steam being constantly removed by the action of the pumps. When the process has been in operation for some time an attendant draws off at intervals a sample of the milk to test its viscosity. When the milk has attained the right density it is run out of the vacuum pan into cylindrical metal coolers. These are arranged to rotate slowly in tanks of cold water, wooden paddles keeping the milk constantly stirred during the cooling process, which occupies two or three hours. The milk when cold is transferred into reservoirs from which the tins are filled by an automatic arrangement delivering the exact amount necessary. After filling, the tins are closed, tested for tightness, and subsequently labelled.

Machine skimmed milk is made in a similar manner, but the milk is first deprived of its cream by means of a mechanical separator. After a preliminary pasteurisation at 90° C. or thereabouts, the separated milk is said to be heated to the boiling point before being drawn into the condensers. The amount of sugar added is larger than in the case of the full cream milks, ranging in the completed product from 40 to 45 per cent.

Scherff's method for making unsweetened condensed milk consists in sterilising the milk by heating at 100° to 113° C. under pressure; evaporating under reduced pressure to from one-half to one-third of the original bulk; the milk is then put into tins,

sealed, and submitted to further sterilisation at 120° C. or thereabouts.

In *Campbell's* process milk is placed in open tanks heated by a water jacket and hot air blown through the milk so as to cause a rapid evaporation of water from it while in continual motion. The temperature is not allowed to rise above 72° C. This process is not to my knowledge used for the production of ordinary condensed milk, but it has been recently utilised for the manufacture of a concentrated milk intended to be afterwards diluted with water and delivered to householders in the same way as ordinary fresh milk. The cream was first separated, the machine-skimmed milk concentrated as above, and the pasteurised cream then returned to it.

METHODS OF MAKING AND SEALING THE TINS.

Condensed milk as retailed is sold in tins which are practically all made by one of two methods. In the first the body of the tin is formed by folding a strip of tinplate into a cylindrical shape and soldering the join. A top and bottom are then soldered on to the opposite ends of the cylinder. The soldering is done so that as far as practicable the solder is all on the outer side and none of it can come into contact with the milk. In the top of the tin is a central hole about one inch in diameter. The tightness of the solder joints may be tested by an ingenious arrangement for producing a vacuum in the tins; those which are not air-tight automatically drop off the apparatus. The hole in the top serves for the filling of the tins, and at the conclusion of this process a small tin cap is soldered on so as to cover the hole.

In the second method solder is not used in making the joints. The body of the tin is formed of a strip of tin-plate by folding the ends so as to form an over-lap joint which is made tight by pressure in a machine. The bottom is made from a circular piece of tin stamped to fit the cylindrical body. When fitted together they are placed in position on a revolving "chuck" whilst a tool turns over the rim of the bottom plate on to the body and fixes the edges. After the milk has been placed in the tin the top is fastened on in a similar manner. The weak points of tins made by this method are where the over-laps of the top and bottom plates cross the over-lap of the body, and it is at these places that leakages are most liable to occur. In some cases a drop of solder is applied to these places to ensure the tightness of the tins.

II.—COMPOSITION OF CONDENSED MILK.

CHEMICAL ANALYSES.

In 1895 Messrs. Pearmain and Moor⁽¹⁾ published the results of analyses of 50 different brands of condensed milk. In the same year Mr. A. H. Allen⁽²⁾ gave figures for 29 brands, some of which were included among those examined by Messrs. Pearmain

* Figures relate to references on p. 62.

and Moor, whilst some were different brands. In 1895 also, figures obtained by Dr. Bernard Dyer⁽³⁾ were published as to the amount of fat present in 17 samples of condensed milk, all except one of which had been prepared from separated or skimmed milk. In their book published in 1897 Messrs. Pearmain and Moor⁽⁴⁾ quoted all these analyses along with a few others by English analysts and also figures obtained by Worcester for American condensed milks. In Appendix XXVIII. to the Report of the Departmental Committee on Milk Regulations is given a table of analyses of 25 samples of unsweetened full cream condensed milk examined in the Government Laboratory during the years 1898 and 1899.

Until quite recently no further reports based on any extensive series of analyses of condensed milks purchased in this country appear to have been published, and the figures given by Pearmain and Moor and by Allen have been used as a basis for statements in various books as to the constitution of condensed milk. Recently Mr. F. J. Lloyd⁽⁵⁾ has published reports to the British Dairy Farmers' Association on a few samples of condensed milk—5 in 1906, 5 in 1907, and 20 in 1909. In these reports the names of the brands are not mentioned, but Mr. Lloyd has been good enough to supply me with information respecting them. In his annual report to the Transvaal Government, McCrae⁽⁶⁾ gives the results of a series of analyses of condensed milk, some being brands sold in England, others being apparently brands special to South Africa. Dold and Garratt⁽¹⁰⁾ published early in 1910 a full report on the examination of 10 brands of full cream condensed milk and 10 brands of machine skimmed. Several public analysts have recently made reports to their authorities on analyses of condensed milk, especially in relation to the amount of fat in the machine skimmed variety. Thus Dr. Bernard Dyer, in January, 1907, reported to the Leicestershire County Council on 19 samples of condensed skimmed milk. Through the kindness of various medical officers of health I am in possession of figures obtained by other analysts in reference to various brands. Dr. Arnallt Jones⁽⁷⁾, of Aberavon, records the analysis of 9 brands of full cream milk and 13 brands of machine skimmed milk.

I have also had the advantage of studying figures supplied at the Board's request by Sir T. E. Thorpe, relating to imported condensed milks examined at the Government Laboratory between April, 1906 and 1909.

For the purposes of this inquiry my colleague, Dr. G. W. Monier-Williams, has also examined a number of samples of various brands obtained from different sources.

The accompanying tables are compiled from the results given by various observers and serve to show the constitution of samples of condensed milk from different sources, and also to indicate the variations which may occur in the same brand at various times. The figures relate to only a comparatively small number of brands, all of which are still on the market. They include productions of the principal manufacturers in various European countries and are meant to be representative rather than comprehensive.

TABLE I.—ANALYSES OF FULL CREAM FULLY-SWEETENED
CONDENSED MILKS.

Brand A. (Switzerland.)

Total Solids.	Fat.	Protein.	Ash.	Lactose.	Cane Sugar.*	Observer.	Year.
77.2	13.7	9.7	1.6	15.0	37.2	Pearmain & Moor	1895
75.00	13.5	10.44	—	—	—	A. H. Allen ...	1895
70.41	11.03	10.51	—	—	—	Do. ...	1895
74.56	9.48	—	2.08	—	—	Govt. Laboratory†	1906
75.48	10.46	—	2.00	—	—	Do.	1906
76.10	9.1	8.0	1.81	14.5	41.5	Transvaal Analyst	1906-7
75.35	10.55	8.4	1.75	13.4	40.8	Do.	1906-7
74.55	9.2	—	1.86	—	—	Govt. Laboratory	1907
73.44	11.24	—	3.47	—	—	Do.	1907
74.67	9.35	—	2.01	—	38.89	Do.	1908
75.08	11.74	—	1.89	—	—	Do.	1908
73.59	9.86	—	2.09	—	39.33	Do.	1908
75.11	10.47	—	2.15	—	37.80	Do.	1908
—	12.6	—	—	—	—	Carter Bell ...	1908
75.27	9.47	—	2.10	—	—	Govt. Laboratory	1909
74.95	10.87	—	2.08	—	39.47	Do.	1909
73.4	11.7	8.9	2.70	50.1	—	Lloyd ...	1909
—	11.97	—	—	—	—	Monier-Williams†	1909
77.4	13.7	—	—	—	—	Arnallt Jones ...	1910
74.80	11.0	9.67	1.9	13.4	39.43	Dold & Garratt ...	1910

Brand B. (Switzerland.)

73.66	11.80	11.40	—	—	—	A. H. Allen ...	1895
76.04	11.04	—	2.12	—	—	Govt. Laboratory†	1906
73.60	10.16	—	2.04	—	—	Do.	1907

Brand C. (Holland.)

76.29	10.40	—	2.27	—	—	Govt. Laboratory	1908
77.68	10.37	—	2.23	—	—	Monier-Williams†	1910

Brand D. (Holland.)

77.53	10.03	—	2.22	—	—	Govt. Laboratory	1907
83.60	8.85	—	2.21	—	—	Do.	1909
—	10.06	—	—	—	—	Monier-Williams†	1909
78.39	10.46	—	2.29	—	—	Do.	1910

* The figure for cane sugar has in many cases been obtained "by difference."

† When more than two analyses of the same brand have been made in the Government Laboratory in one year, the two showing the highest and lowest percentage of fat have been selected for these tables.

‡ These analyses have been made in the chemical laboratory of the Local Government Board.

TABLE I—*continued.*

Brand E. (Holland.)

Total Solids.	Fat.	Protein.	Ash.	Lactose.	Cane Sugar.*	Observer.	Year.
72.0	8.8	7.3	1.7	13.7	40.5	Pearmain & Moor	1895
70.60	5.57	8.32	—	—	—	A. H. Allen	1895
75.54	9.22	—	2.26	—	—	Govt. Laboratory	1906
74.88	9.34	—	2.06	—	—	Do.	1906
75.99	9.30	—	2.28	—	—	Do.	1907
77.16	9.72	—	2.14	—	—	Do.	1907
74.88	9.42	—	2.11	—	—	Do.	1908
74.83	10.48	—	1.95	—	—	Do.	1908

Brand F. (Norway or Denmark.)

74.0	10.7	8.8	1.7	15.4	37.4	Pearmain & Moor	1895
74.25	8.12	8.82	—	—	—	A. H. Allen	1895
77.15	11.24	—	1.99	—	—	Govt. Laboratory	1907
73.97	10.05	—	2.23	—	—	Do.	1908
76.00	8.90	—	2.06	—	41.44	Do.	1908
75.80	11.40	9.20	2.60	52.60	—	Lloyd	1909
72.50	10.1	—	—	—	—	Arnallt Jones	1910
74.80	13.0	8.43	2.05	14.0	37.32	Dold & Garratt	1910

Brand G. (Holland.)

75.01	9.74	—	2.27	—	—	Govt. Laboratory	1907
—	10.05	—	—	—	—	Monier-Williams†	1909

Brand H. (Norway or Switzerland.)

76.30	11.0	9.7	2.30	14.6	38.7	Pearmain & Moor	1895
—	10.92	—	—	—	—	B. Dyer	1895
75.68	9.30	—	2.10	—	—	Govt. Laboratory	1906
76.10	10.40	—	2.00	—	—	Do.	1906
76.36	9.07	—	2.00	—	—	Do.	1907
76.66	10.04	—	2.04	—	—	Do.	1907
73.64	9.99	—	2.17	—	—	Do.	1908
76.48	10.21	—	2.03	—	40.81	Do.	1908
76.30	11.10	—	—	—	—	J. Arnallt Jones	1910
76.53	10.5	8.8	1.91	14.33	40.99	Dold & Garratt	1910

Brand I. (Holland.)

68.10	11.05	10.95	—	—	—	A. H. Allen	1895
—	9.79	—	2.27	—	—	Monier-Williams†	1909

* The figure for cane sugar has in many cases been obtained "by difference."

† These analyses have been made in the chemical laboratory of the Local Government Board.

TABLE I—*continued.*

Brand J. (France.)

Total Solids.	Fat.	Protein.	Ash.	Lactose.	Cane Sugar.*	Observer.	Year.
76.90	9.70	8.95	2.60	—	55.65	Lloyd ...	1909
—	9.80	—	—	—	—	Monier-Williams†	1909
76.62	9.80	9.19	2.10	12.01	39.16	Do.	1910
76.80	9.0	8.45	1.92	12.82	44.61	Dold & Garratt...	1910

Brand K.† (Holland.)

75.93	10.39	—	2.07	—	—	Monier-Williams†	1909
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Brand L.† (Holland.)

78.32	10.25	—	2.31	—	—	Monier-Williams†	1909
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Brand M. (United States.)

72.42	10.79	8.57	2.40	12.02	39.16	Monier-Williams†	1910
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Brand N. (Holland.)

73.84	8.12	—	2.06	—	—	Govt. Laboratory	1906
74.45	8.53	—	2.12	—	—	Do.	1907
76.25	9.96	—	2.30	—	—	Do.	1909
73.40	10.10	—	—	—	—	Arnallt Jones ...	1910
76.73	11.20	9.82	2.78	15.08	38.11	Monier-Williams†	1910

Brand O. (Holland.)

76.8	11.0	8.75	2.05	11.6	43.4	Dold & Garratt...	1910
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Brand P. (Holland?)

76.6	12.4	8.3	2.2	17.6	36.1	Pearmain & Moor	1895
72.4	10.3	9.75	—	—	—	A. H. Allen ...	1895
75.5	10.5	8.93	1.9	14.36	39.81	Dold & Garratt...	1910

* The figure for cane sugar has in many cases been obtained "by difference."

† Brands "K" and "L" were condensed milk in large tins; "K" in a 14-lb. tin, "L" in a 5-lb. tin.

‡ These analyses have been made in the chemical laboratory of the Local Government Board.

TABLE II.—ANALYSES OF FULL CREAM PARTLY SWEETENED
CONDENSED MILKS.

Brand Q.* (France.)

Total Solids.	Fat.	Protein.	Ash.	Lactose.	Cane Sugar.	Observer.	Year.
53.50	17.35	14.87	3.44	17.58	0.26	Monier-Williams†	1910
—	13.95	—	—	—	1.92	Do.	1910

Brand R. (Switzerland.)

45.18	11.03	8.95	2.00	12.25	11.25	Hehner ...	—
43.46	12.62	8.93	2.15	13.96	5.45	Monier-Williams†	1910

Brand S.† (Italy.)

—	—	—	—	16.49	2.85	Monier-Williams†	1909
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Brand T.† (Italy.)

—	—	—	—	17.03	2.78	Monier-Williams†	1909
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TABLE III.—ANALYSES OF FULL CREAM UNSWEETENED
CONDENSED MILKS.

Brand U. (Norway.)

Total Solids.	Fat.	Protein.	Ash.	Lactose.	Observer.	Year.
34.2	10.0	9.0	1.9	13.3	Pearmain & Moor...	1895
35.16	10.40	9.14	—	—	A. H. Allen ...	1895
35.53	10.16	8.69	2.08	14.60	Govt. Laboratory...	1899
36.46	11.03	9.98	1.95	13.50	Do.	1899
35.77	9.73	10.04	2.02	13.98	Do.	1900
35.53	10.43	9.59	2.02	13.49	Do.	1900
34.88	9.96	—	2.00	—	Do.	1906
34.6	11.0	8.82	1.77	12.8	Transvaal Analyst	1906-7
33.08	9.60	—	1.86	—	Govt. Laboratory...	1907
35.03	9.52	—	1.86	—	Do.	1907
33.72	10.94	—	2.09	—	Do.	1907
29.21	8.29	—	1.86	—	Do.	1908
31.11	9.64	—	1.72	—	Do.	1908
34.10	11.40	9.10	2.50	11.10	Lloyd ...	1909
35.48	10.20	8.8	2.00	14.48	Dold & Garratt ...	1910

* Brand "Q" presented some notable peculiarities. Although labelled "machine-skimmed" it was very rich in fat; although declared "partially sweetened" it contained only 0.26 per cent. of added sugar in one sample and 1.92 per cent. in another. It contained 0.66 per cent. of boric acid, the presence of which was declared. The ash, exclusive of the boric acid, was 2.83 per cent., indicating a condensation greater than usual, viz., to one-fourth the original bulk. This milk was imported in large tins.

† Brands "S" and "T" were imported in large tins. Both came from one factory in Italy. Although declared partially sweetened the amounts of added sugar were very small. "S" contained 0.82 per cent. of boric acid and "T" 0.88 per cent. The presence of boric acid was declared but its amount was said not to exceed 0.7 per cent.

‡ These analyses have been made in the chemical laboratory of the Local Government Board.

TABLE III—*continued.*

Brand V.* (Great Britain or Norway.)

Total Solids.	Fat.	Protein.	Ash.	Lactose.	Observer.	Year.
38.0	12.4	8.3	1.7	16.0	Pearmain & Moor...	1895
32.92	10.77	8.02	1.60	11.86	Govt. Laboratory ...	1898
34.38	11.74	8.25	1.88	12.51	Do.	1898
33.26	10.53	8.69	1.93	12.11	Do.	1899
36.04	11.72	10.08	1.96	12.28	Do.	1899
36.92	11.00	8.93	1.88	15.11	Dold & Garratt ...	1910

Brand W.† (Switzerland.)

—	11.04	—	—	—	Monier-Williams¶	1909
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Brand X. (Switzerland.)

—	11.92	—	—	—	Monier-Williams¶	1909
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Brand Y.‡ (Switzerland.)

32.75	11.85	8.48	1.93	9.07	Monier-Williams¶	1910
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Brand Z.§ (United States.)

24.48	6.69	6.47	1.43	8.88	Monier-Williams¶	1910
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Brand AA.|| (Germany.)

11.02	3.1	2.81	0.76	—	Monier-Williams¶	1910
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* Said to be enriched by added cream.

† Imported in large tins.

‡ Called "Evaporated Cream." The chemical composition shows that it is only ordinary condensed milk.

§ A sample of evaporated milk condensed to only one-half instead of one-third the original bulk.

|| A sample of uncondensed milk imported in tins. The analyst was of opinion that it had been adulterated with about 7 per cent. of added water.

¶ These analyses have been made in the chemical laboratory of the Local Government Board.

TABLE IV.—ANALYSES OF MACHINE-SKIMMED CONDENSED MILK.

Brand Aa. (Holland.)

Total Solids.	Fat.	Protein.	Ash.	Lactose	Cane Sugar.	Observer.	Year.
75.5	0.3	12.3	1.6	17.0	44.3	Pearmain & Moor	1895
67.38	0.17	10.20	—	—	—	A. H. Allen ...	1895
—	1.49	—	—	—	—	B. Dyer ...	1895
—	0.2	—	—	—	—	Carter Bell ...	1908
—	0.91	—	—	—	—	B. Dyer ...	1910
—	0.69	—	—	—	—	Do. ...	1910

Brand Bb. (Holland.)

71.3	1.3	11.1	2.5	12.5	43.9	Pearmain & Moor	1895
69.44	0.91	9.13	—	—	—	A. H. Allen ...	1895
—	1.02	—	—	—	—	B. Dyer ...	1895

Brand Cc. (Great Britain or Holland.)

71.0	1.2	9.9	2.0	12.0	45.9	Pearmain & Moor	1895
79.10	4.30	10.44	—	—	—	A. H. Allen ...	1895
—	0.56	—	—	—	—	B. Dyer ...	1895
72.2	1.00	7.65	2.30	61.25	—	Lloyd ...	1909
77.0	0.6	9.52	2.02	12.2	52.66	Dold & Garratt...	1910

Brand Dd. (Holland.)

74.9	2.0	11.5	2.6	13.0	45.8	Pearmain & Moor	1895
72.5	6.5	10.57	—	—	—	A. H. Allen ...	1895
—	2.84	—	—	—	—	B. Dyer ...	1895
—	2.50	—	—	—	—	Carter Bell ...	1908
73.0	1.80	9.15	2.7	59.35	—	Lloyd ...	1909
74.3	0.98	10.3	2.26	11.75	49.01	Dold & Garratt...	1910

Brand Ee. (Holland.)

75.0	1.2	10.5	2.6	16.0	44.7	Pearmain & Moor	1895
—	0.96	—	—	—	—	B. Dyer ...	1895
74.9	1.30	9.00	2.9	61.7	—	Lloyd ...	1909
74.0	0.76	12.08	2.86	18.85	39.45	Dold & Garratt...	1910

Brand Ff. (France or Holland.)

66.6	0.12	10.14	—	—	—	A. H. Allen ...	1895
71.4	0.5	9.6	1.87	14.7	43.5	Transvaal Analyst	1906-7
70.4	2.0	9.3	2.7	56.40	—	Lloyd ...	1909
—	0.62	—	—	—	—	B. Dyer ...	1910

TABLE IV—*continued.*

Brand Gg. (Great Britain or Austria.)

Total Solids.	Fat.	Protein.	Ash.	Lactose.	Cane Sugar.	Observer.	Year.
56.9	1.0	8.5	1.6	15.4	30.4	Pearmain & Moor	1895
75.0	4.18	9.45	2.8	68.57		Lloyd ...	1909
—	0.37	—	—	—	—	B. Dyer ...	1910
—	0.56	—	—	—	—	Do. ...	1910
74.54	0.78	10.33	2.16	10.92	50.35	Dold & Garratt ...	1910

Brand Hh. (Great Britain or Austria.)

75.9	1.20	8.95	2.60	63.15		Lloyd ...	1909
77.06	0.92	9.82	2.25	15.61	38.46	Dold & Garratt ...	1910

Brand Ii. (France.)

71.57	1.52	10.9	2.2	12.02	44.93	Dold & Garratt ...	1910
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Brand Jj.* (Holland.)

73.23	0.58	—	2.63	17.0	40.79	Monier-Williams†	1909
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Brand Kk. (Saxony.)

75.44	0.62	10.0	2.32	16.4	46.10	Dold & Garratt ...	1910
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* This sample was one of condensed milk imported in casks for manufacturing purposes.

† Analysis made in the chemical laboratory of the Local Government Board.

VARIATIONS IN CHEMICAL COMPOSITION.

It is obvious from the figures given in these tables that considerable variations occur in the chemical composition of condensed milks. Not only is this true in regard to different brands, but samples of even the same brand taken at intervals of only a few months may give different figures. The following summary gives the extreme variations shown in the analyses quoted above.

VARIATIONS IN CHEMICAL COMPOSITION OF CERTAIN CLASSES OF
CONDENSED MILK AS INDICATED BY ABOVE TABLES.

	Full Cream.				Machine-skimmed sweetened.	
	Sweetened.		Unsweetened.*			
	Lowest.	Highest.	Lowest	Highest.	Lowest.	Highest.
Total solids per cent....	68.1	83.6	29.2	38.0	56.9	79.1
Fat	8.0†	13.7	8.2	11.9	0.1	6.5‡
Protein	7.3	11.4	8.0	10.0	7.6	12.3
Ash	1.6	3.4§	1.6	2.5	1.6	2.9
Lactose	11.6	17.6	11.1	16.0	10.9	17.0
Cane Sugar	36.1	44.6	Nil.	Nil.	30.4	52.6

* In this comparison brands "Z" and "AA" are left out of account as neither is called "condensed" milk.

† Excluding one sample of Brand E, examined in 1895, which was evidently partially skimmed.

‡ Prior to the passing of the 1899 Act, this particular brand was only partially skimmed.

§ The analytical figures indicate that the milk had probably been treated by a preservative such as boric acid, or sodium bicarbonate added, thus giving rise to the high "ash."

Total Solids.—The variation in this item is evidently dependent partly on the extent of concentration, partly on the amount of added sugar, and partly also on the composition of the original milk, especially as regards fat.

Fat.—This is naturally the most variable constituent of milk and is also the element which lends itself most readily to manipulation. Since 1899 the variations have not shown so wide a range as before, either in the brands sold as full cream or those sold as skimmed, but in some cases even in recent years the amount of fat in supposed full cream milks has been so low as to suggest the possibility of deliberate abstraction. But apart from skimming, variations in concentration will affect the fat content of the product.

The general quality of milk supplied by the cows will also affect the question, and in this connection it may be noted that Mr. Lehmann stated to the Departmental Committee* that Dutch cows do not produce a milk so rich in fat as those of Switzerland; an examination of the above figures tends to corroborate this view. Dutch milks appear to require concentration to a higher degree in order to provide as large a proportion of fat as Swiss or Norwegian made milk.

The variations in fat shown in the tables of brands of milk now sold as machine skimmed are great, the amounts recorded being as high as 6.5 per cent. in one case and 4.3 per cent. in another, but these high figures for fat were obtained before there was a legal obligation to label skimmed milks. Since 1899, the variations have been less. The average amount of fat in 22 analyses made since 1899 and given in the above tables relating to 10 different brands, is 1.13 per cent., and this figure is unusually high owing to one sample exceptionally high in fat ("Gg"). Arnallt Jones states that 13 brands examined showed a range of from 0.3 to 0.8 per cent. of fat. Dold and Garratt's

* Appointed in 1900 by the Board of Agriculture to inquire and report upon the desirability of regulations, under Section 4 of the Sale of Food and Drugs Act, 1899, for milk and cream.

figures from 10 brands of machine-skimmed milk show an average of 0.92 per cent. Nineteen samples, representing 14 brands, examined by Dr. Dyer, give an average of 0.53 per cent. Machine-skimmed condensed milk may therefore be regarded as an article containing usually less than 1 per cent. of fat.

Ash.—In an analysis of condensed milk this is an important figure, as in the absence of addition of sodium bicarbonate or similar salt, or of some preservative like boric acid or of sugar containing mineral matter, the “ash” gives an index of the extent of condensation. Taking 0.7 per cent. as the average amount of “ash” in normal milk, 2.1 per cent. of “ash” in a condensed milk would indicate a concentration to one-third of the original milk.

Extent of Condensation.—On the above basis a considerable proportion of the full cream sweetened milks and most of the machine-skimmed milks show a condensation as great as to one-third, but the unsweetened full cream milks show a less degree of concentration.

Cane Sugar.—The figures indicate a considerable amount of variation, but to a great extent this is probably due more to variations in extent of condensation than to great differences in the proportion of sugar added. Machine-skimmed milks contain usually more added sugar than full cream milks.

Proteins.—These have been estimated in only about one half the cases, but on the figures given they vary in full cream milks from 7.3 to 11.4 per cent., and in machine-skimmed milks from 7.65 to 12.3 per cent. On the whole, machine-skimmed milks, show a slight excess of protein compared with full cream milks, and the firms dealing chiefly in this class of milk do not fail in their advertisements to draw attention to the nutritive value of their products as expressed in amount of protein.

Controllability of Range.—The determination of the precise moment at which to stop the condensing process requires skill and judgment. In some factories it is decided by testing, by means of a viscosimeter, a small sample removed from the vacuum pan, a definite temperature being always employed for the test. At others a simpler method is adopted which depends more on the individual judgment of the attendant. In either case a few minutes more or less at the conclusion of the evaporating process may make a considerable difference in the physical characteristics of the product as regards viscosity. It is not surprising, therefore, that variations exist, and under the conditions of manufacture I do not think that it would be practicable for a manufacturer to turn out invariably a product of the same exact composition even as regards one constituent alone, still less one with the various constituents always present in the same relative amounts.

In the tables above I have not included figures relating to condensed milk made and sold in the United States or in Canada.*

* Figures relating to analyses of a large number of condensed milks sold in Canada, from the Laboratory of the Inland Revenue Department, Ottawa, Canada, were published in May, 1910. (Bulletin No. 208.)

Results of analyses of American condensed milks are given by Leeds⁽⁸⁾, Hyde⁽⁹⁾, and Worcester^(4a). The average figures obtained from the analysis of 15 different brands are given by Leeds as follows:—Water 27·89 per cent.; fat, 8·67 per cent.; casein and albumen, 8·82 per cent.; milk sugar, 11·66 per cent.; ash 1·83 per cent.; cane sugar 40·39 per cent.; milk solids 31·71 per cent.; original milk fat 3·69 per cent.; average number of times condensed 2·52. Some brands mentioned by Worcester were undoubtedly not prepared from whole milk, as they contained only 4, 5, or 6 per cent. of milk fat.

The official requirements of certain foreign countries and British Dominions, in regard to condensed milk, in several cases include minimum limits for fat in full cream condensed milk. (*See pp. 50-56.*) The Board of Trade, after consultation with the Local Government Board, fixed the standard for fat in condensed milk supplied as ships' stores at a minimum of 10 per cent.

PRESERVATIVES.

As a rule manufacturers rely on the large amount of cane sugar present in sweetened condensed milk to effect its preservation. It appears that in a liquid so highly concentrated as ordinary condensed milk, the sugar alone is sufficient to inhibit the growth of bacteria, provided the manufacture has been carried out with due precautions as to cleanliness, and provided the milk has been subjected to a sufficiently high temperature during the process. In regard to unsweetened condensed milk sterilisation at temperatures well over 100° C., after the tins are filled, appears to be sufficient to enable the milk to keep good for a considerable period so long as the tins remain unopened.

Occasionally, however, chemical preservatives have been and are at the present time employed for the purpose of aiding the keeping properties of the milk. Boracic acid or borax has been found, and there seems to be a suspicion that formalin has been occasionally used of late, although I have not been able to obtain definite evidence of this. Even as regards the use of boron compounds, the records are somewhat scanty. From the reports published of samples examined under the Sale of Food and Drugs Acts during recent years I have only been able to find one instance. This was a sample taken in Battersea in 1906; it was described as separated and condensed milk; it was found to contain 30·03 grammes of boric acid per gallon, dissolved in a fluid having the following composition:—21 per cent. extraneous water, 31 per cent. milk devoid of fat, 48 per cent. milk of genuine composition but of the poorest quality. The sample had probably been prepared by mixing together separated milk, condensed milk and water, and it is impossible to say whether the boric acid was originally in the condensed milk, in the separated milk, or added to the mixture at the time of mixing. In 1883 Vignal⁽¹¹⁾ published a report on the product of the Swiss Alpine Milk Company. In this report it is stated that a small proportion of borax was added, amounting to perhaps 0·2 of a grain per gallon in the unconcentrated milk. This was an unsweetened condensed

milk, and according to an analysis by Fresenius, quoted in the report, it contained 2.36 per cent. of inorganic substances of which borax represented 0.63 per cent. (26.69 of the ash consisting of borax). Dr. J. A. Voelcker stated in evidence before the Departmental Committee on the Use of Preservatives and Colouring Matters, that in 1898 he had examined a sample of Australian condensed milk which contained 0.51 per cent. of boracic acid. Dr. J. Spottiswoode Cameron informed the same Committee that of three samples of condensed milk submitted to the Public Analyst in 1898, two contained boracic acid in some form. A statement handed in to the Committee on behalf of the Society of Public Analysts contained a reference by Richmond and Boseley to the use of formalin and boron compounds in condensed milk. In 1904, during a discussion on analyses of condensed milk before the Society of Public Analysts, Moor⁽¹²⁾ referred to some samples of condensed milk which would keep almost indefinitely, but he had been quite unable to find any preservative in them, though he had tested for all the ordinary substances used for the purpose. Kotzine⁽¹³⁾ in an examination of 14 samples of condensed milk, including Swiss, Russian, and Norwegian brands, found boric acid in two samples of Swiss milk, but no preservatives in any of the others. In two unsweetened Norwegian milks he found traces of saccharine. In 1907 Lloyd, in the reports already alluded to, stated that five samples of machine-skimmed milk bought in 1906 in poor districts of London all contained boric acid in proportions varying from 0.25 to 0.43 per cent.; none of the samples contained formalin or salicylic acid. Out of four samples of full cream milk and one of machine-skimmed milk examined in 1907 he found 0.10 per cent. and 0.17 per cent. respectively of boric acid in two samples of full cream milk, the others were free.

During 1909-10, 32 samples of condensed milk examined by Dr. Monier-Williams have been tested for preservatives; in no case was salicylic acid, benzoic acid, or formalin found, nor was boric acid found in any of the small tins of condensed milk as sold to the public. Two varieties, however, of condensed milk imported in large tins holding 14 or 28 lbs. were found to contain boric acid. One was a sample of full cream condensed milk from Italy.* It was only slightly sweetened. One sample contained 2.85 per cent. of cane sugar and 0.82 per cent. of boric acid. Another sample from the same factory contained 2.78 per cent. of cane sugar and 0.88 per cent. of boric acid. In each instance the tin bore a label declaring the presence of boracic acid in the proportion of 0.7 per cent. The other case was a peculiar one as the milk was stated to be "partly sweetened machine skimmed milk," whereas it was full cream milk, and the amount of cane sugar was exceedingly small. This milk came from a French factory; the label indicated that 0.75 per cent. of boracic acid had been added, and also asserted that "When diluted to the consistency of fresh milk, the percentage of Boracic Acid in the milk would not exceed 0.20 per cent." Dr. Monier-Williams

* Pearmain & Moor ⁽⁴⁾ refer to an Italian condensed milk "heavily preserved with boric acid."

found in one sample of this milk not more than 0.26 per cent. of cane sugar and 0.66 per cent. of boric acid. The addition of boric acid to condensed milk is unnecessary for the purpose of preservation where proper precautions are taken in manufacture, and is on other grounds objectionable.

BACTERIOLOGICAL ANALYSIS.

Until recent years condensed milk has been looked upon as a particularly safe food from a bacteriological point of view. It seems to have been generally assumed that the process of preparation gave a practically sterile product in consequence of the temperature to which the milk is subjected in the preliminary processes. Statements made on labels and in advertisements issued in connection with certain brands are likely to encourage this belief. Recent investigations have, however, shown that living micro-organisms are always present in ordinary sweetened full cream and machine-skimmed milks, and sometimes in considerable numbers.

"Blowing" of Tins.—Fully sweetened condensed milk in unopened tins may remain apparently perfectly good for months or even years, the micro-organisms present being unable to develop in the strong saccharine solution. On the other hand it is well known in the trade that a considerable number of tins become "blown" by evolution of gas due to the development of micro-organisms; this usually occurs during the first six weeks after canning. If such tins have come into the hands of retailers they are either returned to the merchants or reported as "blown," the value being allowed for in settling accounts.

The proportion of tins which become blown seems to vary with different manufacturers and with the same manufacturer at different periods; in some batches of tins the loss from this cause may be negligible, whilst other batches may show a large proportion. The proportion of cans of condensed milk examined at the time of importation which are rejected for this cause by Port Sanitary Authorities does not appear to be very large.

Cause of Blowing.—The blowing of tins of condensed milk arises from the formation of gas. Probably different organisms may produce the result under certain conditions. There does not appear to have been much research on this subject. In 1892 Cassedebat⁽¹⁴⁾ investigated the matter. He failed to find bacteria either aerobic or anaerobic; in nearly all cases moulds were present. He concluded that alterations in condensed milk are of a chemical or physical character and not of bacterial origin. His experiments even convinced him that, before dilution, condensed milk had actual bactericidal properties. Pethybridge⁽¹⁵⁾ in 1906 published an interesting account of an elaborate investigation undertaken by him at the instance of a firm making condensed machine-skimmed milk in Ireland. He considered that the cause of blowing in the batches of blown tins submitted to him was a species of yeast (or torula) belonging to the class of "wild" yeasts. He came to the further conclusion that this

wild yeast could be traced to the dirty condition of certain farms supplying milk to the factory, and that it survived the high temperatures employed in the process of manufacture (milk raised twice to the boiling point). He states that great improvement resulted from attention to the sources of supply and the exclusion of dirty milk. In view of the fact that yeasts, even when in the spore condition, are stated not to be very resistant to heat, it is difficult to accept his theory. His experiments proved, however, that the yeast isolated by him could produce gas when inoculated into condensed milk, notwithstanding the large amount of sugar present, in this respect differing from bakers' yeast. A yeast of this kind gaining access to the condensed milk during the process of cooling and before canning might readily cause blowing, but in the absence of evidence of a special power of resisting heat it is difficult to believe that the yeast could have been present in the original milk and have survived the condensing processes.

Bacteriological Analysis of Condensed Milk.

As already stated condensed milk for a time was considered as usually a sterile product and little attention seems to have been paid to the bacteriological analysis of this article until quite recently, and nothing was known as to the nature or number of the organisms likely to be present. In his Annual Report for 1898, Dr. Hope, of Liverpool, stated that 34 samples of various brands of condensed milk had been examined bacteriologically, and out of these only one appeared free from micro-organisms. In 1901 Klein⁽¹⁶⁾ drew attention to the fact that condensed milk contained micro-organisms. He examined eight samples, four bought as "superior" and four as "inferior" brands. All were non-sterile, but the inferior brands contained more micro-organisms than the others. Non-liquefying white staphylococci were found in the superior brands and liquefying white or yellow staphylococci in the inferior. He found no bacillus coli or coli-like organisms and no spores of anaerobes either pathogenic or non-pathogenic.

Heggs⁽¹⁷⁾, in 1905, examined at the Brighton Municipal Laboratory samples of twelve different brands of condensed milk, including full cream and machine-skimmed sweetened milks and one full cream unsweetened milk. The latter, although declared to be sterilised, was found to contain living bacteria to the number of 5,450 per c.c. after four days' incubation at 20° C. The other brands contained organisms, capable of growing on gelatine at 20° C., in numbers varying from 230 to 70,940 per c.c.; organisms growing on agar at 37° C. varied from 120 to 44,200 per c.c.

In 1908 a well-known firm arranged for a bacteriological examination of their milk and published the result in one of their advertisements. Four tins purchased from different shops were examined, the number of microbes capable of development in a gelatine plate (aerobically) at 20° C. averaged 1,900 per c.c.; the

number capable of development in agar plate (aerobically) at 37° C. averaged 860 per c.c. The bacillus coli was not found in 50 c.c. of milk and the bacillus enteritidis sporogenes was found to be absent from 100 c.c. of milk. Inoculation tests made on seven guinea-pigs from three different tins of milk showed the absence of living tubercle bacilli.

In the Annual Report for 1908 of the Medical Officer of Health of St. Marylebone, Dr. Meredith Young states that three samples of condensed milk were submitted to bacteriological examination. In one case it was certified that "from 0.01 c.c. of this milk a rich growth of streptococcus was obtained and in larger quantities in addition to the streptococcus the bacillus subtilis and a micrococcus was found." The milk was certified as unfit for human consumption; the dealers were communicated with, and they withdrew from sale all their stock of this milk.

Klein⁽¹⁸⁾ published in 1909 the results of a bacteriological examination of 32 samples of 11 brands of sweetened condensed milks. He came to the conclusion that "all brands of sweetened condensed milk contain microbes, aerobic and gas forming anaerobic, some brands more than others, but even of the same brand one sample shows vastly different numbers of these microbes than another." Gelatine plate cultures were made in the case of 12 samples out of the 32. The number of colonies after three days' incubation at 20° C. varied from 20 to over 2,000 per gramme. Agar plate cultures were made from each sample; the number of colonies developing at 37° C. varied from 130 to over 2,000 per gramme of milk. Tins of the same brand varied considerably; one brand varying from 130 to over 2,000 per gramme, another from 160 to over 2,000 per gramme. Twenty-eight out of 32 samples showed the presence of streptococci in broth cultures infected with one-tenth of a gramme of the milk. In addition to streptococci the broth cultures revealed various kinds of bacilli, including the bacillus subtilis, motile bacilli, also diplococci, staphylococci, yeast cells, &c. The presence of acid and gas forming microbes was discovered in several instances, whilst 19 out of the 32 samples showed the presence of sporing anaerobes capable of clotting milk or of causing the "enteritidis change." Dold and Garratt⁽¹⁰⁾ examined samples of 10 different brands of full cream and 10 of machine-skimmed milks purchased at retail shops in London. They found none of the samples sterile, not even an unsweetened full cream milk supposed to be sterilised after condensation. This sample, however, showed the smallest number of organisms, only 40 colonies per c.c. developing on gelatine after three days' incubation. The bacteria in the other full cream milks varied from 700 to 110,000 per c.c., whilst the machine-skimmed milks contained from 20,000 to 120,000 organisms per c.c. In no case was the bacillus coli or the bacillus enteritidis sporogenes present in 1 c.c., but in one case the bacillus coli was recovered from 10 c.c. In eight cases a streptococcus was found in 1 c.c. of milk, and in three of these the streptococcus could be recovered from one-tenth of a c.c. No pathogenic organisms were detected.

I have had an opportunity of examining several (unpublished) reports on the bacteriological examination of condensed milks, and these corroborate the results found by the observers already mentioned. There is abundant evidence therefore that condensed milk as sold is not a sterile product, that various brands may contain living micro-organisms, even those supposed to have been efficiently sterilised, and that different samples of the same brand may vary in bacterial content; at the same time, it should be noted that the process of condensation markedly reduces the number of bacteria as compared with the number in ordinary cow's milk. The organisms found in condensed milk include streptococci staphylococci, diplococci, spore-bearing bacilli of the subtilis type, lactic acid-producing organisms, anaerobic organisms of the type of bacillus enteritidis sporogenes, sarcinae, yeasts, &c.

The question arises as to the origin of the micro-organisms. Do they consist merely of microbes which have found access to the milk after condensing and during the processes of cooling and filling the tins, or do some of them represent germs which have survived the heat employed in the preliminary stages of manufacture?

From the figures given by several bacteriologists as to the thermal death point of bacteria, one would expect that practically all the germs in the original milk would be killed by the preliminary sterilisation. Flügge⁽¹⁹⁾ and others, however, have shown that pasteurisation at 70° C. does not necessarily destroy even non-spore-forming bacteria; heating to 100° C. for a short period may be insufficient to kill the spores of butyric acid forming bacilli, whilst the spores of the peptonising bacteria are still more resistant.

Drs. Gordon and Elmslie were commissioned to make an investigation on behalf of the Board and to report specially on any organisms present which appeared to have been present in the original milk (*see* report, Addendum II.). The results of their examination of 15 different brands of condensed milk show that with the exception of four unsweetened milks (presumably sterilised after canning) every one of the 11 other brands contained a streptococcus which in nine cases was isolated and proved to be of the type of streptococcus faecalis. It is highly probable that these were derived from the original milk, and the anaerobic spore-bearing bacilli found in 10 brands were possibly also derived from the original milk.

As an incidental part of an investigation, which will be reported later, Professor Delépine also took note of this point. Motile spore-forming bacilli and cocci growing aerobically were found by him in the original milk and also in the finished article; similarly anaerobic bacilli were present in both. From the original milk and also from the condensed milk it was possible to isolate the bacillus mesentericus ruber and the bacillus mesentericus vulgaris. The evidence is conclusive therefore that notwithstanding the heat employed and the presence of a large amount of sugar, bacteria in milk may escape destruction during the process of condensing and may be found in the finished product.

In view of experiments recorded by Rosenau⁽³⁷⁾ and others on the thermal death points of various bacteria which indicate that the germs of typhoid fever, diphtheria, cholera, and dysentery are destroyed at temperatures about 70° C., it would appear that the bacteria causing the common specific infections are probably all killed if the processes of pasteurisation and condensation are carried out under the conditions which ordinarily obtain at a factory with a satisfactory plant.

The experiments recorded above suggest, however, that complete destruction may not occur in the case of certain streptococci. Also the peptonising bacilli of Flügge are probably not destroyed in the condensing process, and these are believed by some to be associated with the causation of summer diarrhoea in infants.

Although in a few instances bacilli of the coli type have been found in condensed milk it appears probable that coli bacilli of intestinal origin present in the original milk are as a rule destroyed during the manufacturing processes.

Conflicting evidence exists as to the resistance to heat under various conditions of the tubercle bacillus in milk, and as the possible presence of tubercle bacilli in condensed milk is important from the point of view of infant feeding, it was thought desirable to put the matter to the test of a special experiment for the purposes of this report, and Professor Delépine was asked to carry out the investigation. Through the courtesy of the London manager of a firm who make full cream condensed milk in this country, I was able to arrange for the whole process of condensing to be performed at one of their factories on tuberculous milk, the whole of the processes being carried out exactly in accordance with the usual procedure in the factory. The fresh cow's milk used for the experiment was mixed with milk rich in tubercle bacilli obtained from a tuberculous cow, along with milk artificially infected with cultures of tubercle bacilli from a bovine source. The infected milk proved to be highly virulent. Professor Delépine made inoculation experiments with materials obtained at various stages of the condensing process and with the finished product. Full details of these experiments will be published later, along with another report by Professor Delépine upon a similar investigation in connection with dried milk. Meanwhile, it may be stated that the milk strongly infected with virulent tubercle bacilli lost, after condensing, its power to infect guinea-pigs on inoculation. The tubercle bacilli were therefore destroyed by the condensing process as carried out at this particular factory, and it is probable that the methods usually employed by other manufacturers of condensed milk are equally successful in this respect.

The plate colonies made by Professor Delépine from milk at various stages during the process of condensing, indicated that the majority of the organisms present in the original milk are destroyed by the primary pasteurisation, but also showed that milk may be infected with organisms from the air, or by other means, during the various processes subsequent to the condensing.

It is probable that the larger proportion of bacteria found in condensed milk have gained admission during the processes of cooling and of filling the tins.

Condensed Milk as a Culture Medium.

There is some evidence that sweetened condensed milk of the viscosity aimed at by the manufacturers is not a favourable medium for the development of many bacteria.

Sandilands⁽³⁴⁾ exposed samples of Nestlé's milk to the air of a laboratory for 24 hours, and then incubated in the open tins at 22° and 37° C., respectively. After two days at 22° C. the organisms had increased from 60 to 100, and after three days to 250 per c.c.; the number then diminished, being only 150 after eight days. After two days at 37° C. the bacteria had multiplied from 80 to 200, and after three days to 600, diminishing to 150 after four days.

Heggs⁽¹⁷⁾ estimated the number of bacteria in various brands of condensed milk after the tins had been exposed to the air of the laboratory for from 3 to 11 days. Most of the brands showed only a comparatively small increase in the number of bacteria, but a few showed a more marked increase, particularly a sample of a machine-skimmed brand, the gelatine count rising after three days' incubation at 22° C. from 21,800 to 114,740 per c.c. It is noteworthy that this sample was observed to be less viscid than the others.

On the other hand, when diluted, condensed milk is a very favourable medium for the growth of bacteria. Sandilands found that on diluting Nestlé's milk with 10 parts of water a rapid increase of bacteria took place, the number reaching 803,200,000 per c.c. after four days' incubation at 22° C., the mixture being then coagulated and putrid. A similar mixture, incubated at 37° C., was curdled and musty after 24 hours, and contained over 11 millions of bacteria per c.c.

Practicability of Bacterial Standard for Condensed Milk.—It has been suggested that a bacterial standard should be laid down for condensed milk on the basis of Houston's⁽²⁰⁾ suggested standard for fresh milk, but making allowance for the condensation of the milk. This means permitting 300 bacillus coli and 3,000 streptococci per c.c. of the finished product. In view of the enormous destruction of organisms by the temperatures attained by the milk during the process of manufacture, it would seem that the bacillus coli should be entirely absent from condensed milk and streptococci should be present in smaller numbers than in ordinary milk. The suggested standard, therefore, appears far from stringent and would tend rather to favour laxity than to encourage systematic carefulness. What is wanted is some means of ensuring attention to strict cleanliness in every detail, and rigorous exclusion of all kinds of contamination from the time of milking the cows until the condensed milk is sealed up in the tins.

III.—DISTRIBUTION AND USES OF CONDENSED MILK.

SIZES OF TINS.

Condensed milk is imported in large tins containing 5 lbs., 7 lbs., 14 lbs., or 28 lbs., and machine-skimmed milk is occasionally imported in casks containing 3-5 cwts. In these cases the milk is intended for the trade purposes referred to below.

For retail purposes full-cream condensed milk is ordinarily put up in tins holding about 15 ozs. (so-called 1 lb. tins) and sold retail at $5\frac{1}{2}d.$ for some brands and $4\frac{1}{2}d.$ for others. Some firms also put up smaller tins retailed at $3d.$

Machine-skimmed milk is also frequently put up in tins holding about 15 ozs., which are usually retailed at $3d.$ This class of milk is often retailed in smaller tins which may vary in size and price. Some are retailed at a $1d.$ a tin. The weight of the milk in one of these $1d.$ tins proved to be slightly less than 3 ozs. It has been stated that these small tins are put up for the convenience of miners and others for use in tea.

SALE FROM BULK.

I am informed that it has recently become a common practice in certain poor districts of London for shop-keepers to open large tins of machine-skimmed condensed milk and retail it in quantities as small as farthingworths, putting it into customers' own vessels. This is open to objection both on account of opportunities of contamination and because the shopkeepers are said to sell the article as "condensed milk" without the qualifying words "machine-skimmed." The latter practice may be worthy of consideration by authorities administering the Sale of Food and Drugs Acts. It was further stated to me that in certain districts when persons bought small packets of tea, condensed milk for use with the tea was supplied in the form of a smear on paper.

USES OF CONDENSED MILK.

(a.) *Domestic and Manufacturing.*

In domestic use condensed milk, whether full-cream or machine-skimmed, is employed as a substitute for ordinary fresh cows' milk, *e.g.*, in tea, coffee, or cocoa. It is also used in the making of milk puddings, custards, &c., for various other cookery purposes, and for the feeding of infants and children.

Both full-cream and machine-skimmed condensed milk are largely used in the manufacture of milk chocolate, caramels, and other sweets, and in making confectionery, certain kinds of bread, biscuits, &c.

(b.) *In the Dairy trade.*

Considerable amounts of full-cream condensed milk, either unsweetened or only slightly sweetened, are imported in large tins.

There is good reason to believe that a considerable amount of such milk is purchased by dairymen, who mix it with water to a suitable consistency and utilise the product to expand their supply of ordinary fresh milk. Analyses of Italian and French milk supposed to be used for this purpose are given in Chapter II.* (p. 12, Brands Q., S., T.).

I have seen a circular issued to dairymen and others "for private circulation only" by a firm in London offering "Italian extract of milk" in 14 lb. or 28 lb. tins: it is specially announced that to insure privacy the cases are unlabelled. The directions for using declare that every 14 lb. tin of extract is to be made up with the addition of cold water to eight imperial gallons and then added to three times its own quantity of fresh milk, and so on in proportion. "Great care should be taken in mixing and straining."

The practice of mixing condensed milk with fresh cows' milk is said to be most prevalent in times of special shortage, when there may be a large demand for condensed unsweetened milk for this purpose, even small 1 lb. tins being bought, and occasionally even the fully-sweetened variety utilised. But, apart from the difficulties caused by a shortage in the supply of fresh milk, there is reason to believe that some dairymen make a fairly constant practice of adding diluted condensed milk to genuine fresh cows' milk.

The mixing of unsweetened, or slightly sweetened, condensed milk with cream is also said to occur. Mr. H. Droop Richmond states that this is "now a fairly common practice, especially in the North of England."†

In the annual reports of the Principal Chemist of the Government Laboratory, reference is made to the importation of condensed milk under the description of "cream" (1905, page 21; 1906, page 23).

LABELS AND ADVERTISEMENTS.

Labels.

The great majority of small tins of imported condensed milk, sold to the ordinary purchaser, come into this country already fully labelled; the labels, printed in English, are put on before the tins leave the condensing factory, and the tins are then packed in cases for export, 48 or more in a case. This system enables importers to comply with Section 1 of the Sale of Food and Drugs Act, 1899; it also possesses the advantage of saving handling of the goods in this country, as the cases can proceed direct to retailers, without being opened by the wholesale distributors who receive them on importation.

Statements on Labels.

In addition to any statement required by the 1899 Act, in the case of "condensed separated, or skimmed" milk, the labels on

* See also Pearmain & Moor, "The Analysis of Food and Drugs," p. 81.

† Analyst, May, 1909, page 210.

imported condensed milk bear a declaration, as required by the Merchandise Marks Act, that the milk was made in Switzerland, Holland, or France, as the case may be. The label usually contains also a picture or design registered as a trade-mark, and a name denoting the brand of milk. Often directions are added as to the method of using the milk. In addition, further statements are frequently made on the label indicating the specially high qualities of the milk; the care taken in its manufacture; or other excellencies claimed for the product. In several instances the labels advertise either another brand of full cream condensed milk made by the same makers—which, as explained elsewhere, may have a misleading effect—or such things as tea or margarine sold by the retail firms who sell the milk.

Re-labelling.

It has been alleged that labels on condensed milk tins as they are imported are sometimes removed and replaced by others, and this has been done in certain cases such as those referred to at the end of the next section of this report. No doubt cases of fraudulent re-labelling may have occurred, but I have found no evidence to suggest its being at all a common practice. Re-labelling is carried out usually for reasons which render it a justifiable procedure: thus, occasionally a “blown” or burst tin may cause the whole of the labels in a case to become dirty so as to require renewal; the tins are, therefore, re-labelled. In exceptional cases the importers may supply retailers with fresh labels, so that the cases may not need to be returned to the importer’s warehouse. As a rule, however, importers of tinned goods appear to be chary of allowing retailers to have fresh labels of standard brands for such a purpose.

Brands and their meaning.

The number of firms engaged at home and abroad in making condensed milk for the British market is small, but the number of brands is very large. I have been able to make a list of over 100 different brands of machine-skimmed, and about 40 brands of full-cream, condensed milks, which are on the market at the present time in this country, or which have been on sale recently. There are probably many others, for fresh brands are continually appearing. In addition there are a number of brands, not on sale here, which are exported to other countries.

Each large firm has certain leading brands which bear its name and which in the course of time have acquired a definite reputation. A firm may have several such brands; in some instances one brand may indicate the best quality, inferior qualities being sold as other brands, but in other cases the same milk may be sold under various brands.

A similar practice exists with other canned goods. I was informed that one reason for it was to prevent too great monotony in the display in a retailer’s shop, but another reason appears to be that it gives the customer an apparent liberty of choice. In certain parts of the country one design may meet with special

favour, whilst a different brand appeals more to another district, even though the same article of the same quality is sold in each case. Further, some makers when supplying condensed milk to any retail or wholesale dealer who is prepared to place a large order, provide and fix labels bearing a brand reserved exclusively for the particular dealer, who thus retains for himself the profits accruing from the demand for this particular brand which may have been created by his energy in pushing the sale of the article.

A good many brands contain no indication on the label, either of the manufacturer, or of the wholesale dealer responsible for their distribution. An examination of the labels in my possession of 109 different brands of machine-skimmed condensed milk shows that 53 contain the name of the manufacturer or importing company; 19 bear the name of a responsible retail dealer; whilst 37 have no indication whatever of the firms responsible for issuing them. Of 34 labels of full-cream milk, 20 bear the name of the manufacturer or importing firm; 6 give the name of the responsible retailer; whilst on 8 neither manufacturer's nor retailer's name is mentioned.

A special explanation of the occasional ephemeral appearance of a brand was given to me. Occasionally something goes wrong with the process of condensing, the result being that the milk is too thick, too thin, or otherwise commercially inferior in quality. Makers do not care to put such a milk into tins bearing the label of an established and well-known brand, as it would tend to lower the reputation of the brand. Special labels may be printed bearing a more or less attractive title and picture, and a new brand is thus established. Neither manufacturer's nor importer's name appears on the label. Such milk is usually sold at a lower price than a known brand, and when the batch is sold out the particular brand may never be used again.

Formerly defective, or inferior, batches of condensed milk were sometimes sold cheap to speculators, who bought the whole lot after the old labels had been stripped off, and attached some new label to the tins, which were then disposed of at a cheap rate. The Condensed Milk Clearing House and Defence Association have recently decided that, as far as their members are concerned, this practice shall not occur in future. I understand that arrangements have been made for utilising such milk, when sound and wholesome, for suitable manufacturing purposes.

I.—CONDENSED MILK AND INFANT FEEDING.

PRELIMINARY REMARKS ON THE CONSTITUTION OF HUMAN MILK AND COWS' MILK.

With regard to all mammals it may safely be assumed that, unless in very exceptional cases, the best food for the young animal is the natural milk secreted during lactation by the healthy adult female of the same species, and that any other food, however similar in chemical composition, is likely to yield less satisfactory results as regards the health and power of resistance to disease of the suckling.

Hutchinson⁽²¹⁾ has suggested that the difference in chemical constitution of cows' milk and human milk is related to the different requirements of the young. The more rapid growth of the calf as compared with the infant demands a larger proportion of building material (*i.e.*, proteins and mineral matter) in cows' milk.

Recent physiological research indicates that in addition to quantitative variations in composition of the milk of different species, as regards fat, mineral substances, and proteins, there are also qualitative differences, dependent on the species, in the nature of each of these substances, and that these variations markedly affect the question of digestibility and assimilation and render the milk of any species of animal less suitable for the nutrition of the young of another species.

It has been suggested⁽²²⁾, ⁽²³⁾ that milk probably possesses certain bio-chemical properties which are specific in the milk of every species and that "variations in the milk of different animals are not purposeless but serve definite requirements in developing the digestive organs of the young." This being so, breast feeding is the only physiologically correct method of rearing the human infant. When circumstances render this impracticable, the feeding by substitutes should be carried out so as to adapt the food as far as possible to the physiological needs of the infant and to its digestive and assimilative capacity.

The chemical differences between human milk and some of the substitutes used in artificial feeding are very marked. This is shown in the following table:—

Comparison of Human Milk with certain substitutes.

Constituent.	Human* Milk.	Cows* Milk.	Condensed Milk diluted with two parts by weight of water.†		
			Full cream unsweetened "U."	Full cream sweetened "A"	Machine- skimmed sweetened "Dd."
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Total Solids ...	13·6	12·0	11·83	24·93	24·77
Fat ...	4·0	3·5	3·4	3·67	0·33
Casein ...	0·6-1·0	3·0	—	—	—
Lactalbumin and lactoglobulin	0·5	0·3-1·0	—	—	—
Total Proteins ...	1·1-1·5	3·3-4·0	2·93	3·02	3·43
Milk Sugar ...	6·4	4·4	4·83	4·47	3·92
Mineral matter ...	0·14-0·28	0·7	·66	·63	0·75
Cane Sugar ...	nil.	nil.	nil.	13·14	16·33

* Modified from Table in Pritchard: "The Physiological Feeding of Infants." p 438.

† Based on analyses by Dold & Garratt of Brands "U"; "A" and "Dd." See Chap. II.

The figures given above do not represent the composition of sweetened condensed milk as actually given to babies: a dilution to one-third would produce a syrupy liquid far too sweet. In the strength capable of being employed the percentage of the different

ingredients would be reduced to about half of the above figures or less. Even as the figures stand striking differences are apparent. Cows' milk differs markedly in regard (a) to the proportion of mineral matter* and (b) to the relative proportion of different proteins, the lactalbumin and lactoglobulin forming a smaller proportion of the total proteins than in human milk.

Unsweetened condensed cows' milk shows the same differences from human milk as uncondensed cows' milk. In addition, owing to the heat used in the processes certain enzymes present in fresh milk have been lost. The actual importance of these enzymes from the point of view of nutrition is not yet established, but they possibly serve some useful purpose, perhaps by stimulating the formation in the body of the infant of certain substances.

Sweetened condensed milks differ still more markedly from human milk owing to the addition of a large amount of sugar of a different type to that normally present in milk. The result is a product containing an enormous disproportion of carbohydrates compared with the other essential food elements.

The machine-skimmed variety still further departs from human milk in being virtually deprived of fat, which is an absolute necessity in the food of the human infant, its absence leading to serious evils. Carbohydrates such as sugar and starch cannot successfully replace fat in the diet of infants: in fact, clinical observations have suggested that an excess of carbohydrates (such as sugar) in a diet appears rather to accentuate the bad effects of fat deficiency in the production of rickets.

The amount of fat in healthy human milk varies from 3 to 5 per cent. (generally between 3 and 4 per cent.), and it has been suggested that any proportion below 3 per cent. must be considered unsatisfactory for continued use. A diet consisting largely of skimmed milk practically represents fat starvation and is likely to lead to injurious results on the growth and development of the child.

MACHINE-SKIMMED CONDENSED MILK AND INFANT FEEDING.

Injurious Results.

There is universal agreement in medical opinion as to the dangers arising from feeding infants on skimmed milk, either fresh or condensed. As long ago as 1894 Mr. Preston Thomas in giving evidence before a Select Committee on Food Products Adulteration stated that the Local Government Board had received a memorial signed by very eminent members of the medical profession in London, analysts and others as to the harm caused by the use of inferior brands of condensed milk made from skimmed or separated milk.

The grave objections to feeding infants on condensed machine-skimmed milk have been frequently urged since, and may be regarded as having been established on a large and substantial basis

* In human milk lime and phosphorus are less abundant than in cow's milk, but a much larger proportion of the phosphorus exists in organic combination. The proportion of lecithin is greater in human milk.

of clinical observation. Among modern writers Pritchard⁽²⁴⁾, Hutchison⁽²¹⁾, Fowler⁽²³⁾, Still⁽²⁵⁾, Cautley⁽²⁶⁾, ⁽²⁷⁾, Sutherland⁽²⁸⁾, and others have pointed out the necessity of fat in the diet of infants and directly or inferentially have strongly condemned the use of machine-skimmed condensed milk, and many medical officers of health have referred to the practice as contributing to infantile mortality. The injurious results of this method of feeding, are malnutrition (as indicated by emaciation and atrophy), rickets, scurvy. Infants so fed show lowered vitality, with consequent lessened resistance to all diseases, and with increased liability to certain diseases such as diarrhœa.

A considerable proportion die during the first year of life, thus swelling the statistics of infantile mortality; those which survive are apt to be stunted, ill-developed, of poor physique, and physically and mentally of a less efficient type.

Even when malnutrition is not pronounced, a diet showing a marked excess of carbohydrates in relation to the other food elements appears to result in perverted metabolism leading to the overgrowth of mucoid forms of connective tissue as compared with more highly organised tissues, and the infant is in consequence more liable to bronchitis, pneumonia, tonsillitis, adenoids, and diarrhœa.

Rickets in infancy or early childhood is responsible for a considerable proportion of cases of convulsions and other diseases of the nervous system, and for certain respiratory disorders in later life. The bone deformities due to rickets may seriously impair efficiency; if affecting the chest wall they may predispose to pulmonary tuberculosis; when affecting the pelvis they may gravely increase the risks incidental to child-birth.

Evidence as to the Extent of the Practice of Feeding Infants on Machine-skimmed Condensed Milk.

Before the passing of the Sale of Food and Drugs Act, 1899, undoubtedly a considerable number of babies were fed on skimmed condensed milk. Up to that time the labels of certain brands had either no indication that they were made from skimmed milk or the intimation might be easily overlooked owing to its small type and obscure position. The Select Committee on Food Adulteration were satisfied that "inferior brands of condensed milk" (by which they meant those made from skimmed milk) were "largely" used for feeding infants and young children. They were also satisfied as to the injurious results of such feeding and recommended the declaration on the label in large type of the milk having been skimmed, and in addition a printed notification that such milk was not suitable for feeding infants and young children.

Most people probably believed that the official requirements as to labelling which are now in force* had resulted in discon-

* Sale of Food and Drugs Act, 1899, Sections 1 (c) and xi., prohibit the importation or sale of "condensed separated, or skimmed milk, except in tins or other receptacles which bear a label wherein the words 'machine-skimmed milk' or 'skimmed milk,' as the case may require, are printed in large and legible type."

tinuance of the use of machine-skimmed condensed milk as a food for babies, or that the practice had become so rare as to be almost a negligible matter. That was my own impression before commencing the present inquiry. I soon found, however, that the practice had by no means ceased: on the contrary, the evidence I have obtained leads me to conclude that in certain districts a really considerable proportion of babies are fed almost exclusively on this diet.

That this is so in some of the poorer districts of London I have been able to ascertain by personal investigation of a number of cases in which it was alleged that machine-skimmed milk had been used. I find that the medical officers of health of several of the London Boroughs are well aware of this practice and consider it to be a serious evil.

In regard to the provinces the evidence available points to considerable variations in different districts. Thus, Dr. Robertson found it not common in Birmingham to feed infants on skimmed condensed milk, whilst in other districts (among them Sheffield) he knew from personal observation that such milks were used. Dr. W. W. E. Fletcher ascertained that tinned skimmed milk was largely used in Middlesborough for infant feeding.* But although the extent of the practice varies in different parts of the country there is evidence from nearly all parts that this material is used and that in some districts its employment is probably extending.

In connection with the use of data collected by health visitors and others, it is well to draw attention to two considerations which should be remembered in estimating the extent to which condensed skimmed milk is used.

(1.) *Differentiation of the kind of Condensed Milk used.*—I found, and others have had the same experience, that amongst the poor, probably without any intention to deceive, the name of a well-known kind of full-cream milk is used as synonymous with condensed milk. If inquirers rest satisfied with the statement that the child is fed on this milk without asking further as to the "brand," the statistics founded on such inquiries may not reveal the real proportion of machine-skimmed condensed milks actually in use.

(2.) *Determination of total numbers of infants fed otherwise than by breast feeding.*—In some districts, through insufficiency of staff, only one visit may be paid to houses in which infants have been born, and that during the first week of life. In a very large proportion of such cases the infant is said to have been "breast fed" whereas inquiries a week or so later would, perhaps, have revealed the use of some artificial food. In several instances, I have found on personal inquiry that babies entered in the records of health visitors, as breast fed, were being fed a few weeks later on condensed skimmed milk.

The evidence of shop-keepers, although not conclusive by itself, helps to confirm the opinion as to the extensive use of machine-skimmed milk for baby feeding. In various parts of the country

* Reports to the Local Government Board on Public Health and Medical subjects. New Series No. 42.

shop-keepers have stated that there has been a large increase in the sales of machine-skimmed condensed milk, and that they have reason to believe that such milk is largely used among the poor for feeding babies as well as for ordinary household purposes. The increase (*see* p. 5) in imports of machine-skimmed condensed milk also suggests an extending use of this article for baby feeding as well as for ordinary household purposes.

Circumstances Encouraging the use of Machine-skimmed Milk.

It will be asked how it is that parents give their babies milk from tins bearing the words "Machine-skimmed Milk" plainly printed on the labels. From personal conversation with mothers I think the answer may be summed up in the words "poverty" and "ignorance." Some mothers who resort to condensed milk know that the full cream variety is superior but not in what respects, and they are tempted by poverty to buy the cheaper article. They would not think of using ordinary fresh skimmed milk for their babies; but the presence of sugar in and the viscosity of the condensed variety give a fallacious appearance of richness and render the food more satisfying to the baby.*

I found that some women were under the impression that all condensed milks were of the same composition, all consisting of pure whole milk and sugar. They never realised that the words "machine-skimmed" implied impoverishment. This attitude of mind is encouraged by the fact that in the shop windows show-cards advertising a brand of condensed milk frequently contain no suggestion that it is machine-skimmed milk. The effect of other statements on labels, &c., in creating a misleading impression is further referred to in Chapter V.

Another factor tending to encourage the use of machine-skimmed milk is that it is more profitable for the retailer to sell this variety than full cream condensed milk. Figures put before me indicate that a retailer may make a profit of 10 per cent. on a well-known brand of full cream milk, but 15 to 20 per cent. on certain brands of machine-skimmed milk.

FULL CREAM CONDENSED MILK AND INFANT FEEDING.

It is necessary to consider this subject in some detail, as considerable divergence of medical opinion exists in regard to the extent to which full cream sweetened condensed milk is a suitable food for babies, and it would be urged by some that administrative action taken to discourage the use of skimmed milk for infant feeding, would be incomplete unless it were extended to all condensed milks. Many medical men in general practice are convinced of the suitability of the full cream variety and recommend it when breast feeding is impossible. I obtained a considerable amount of testimony to the effect that full cream condensed milk is largely used for feeding infants without appreciably bad results in the majority of cases.

On the other hand some medical men hold the view that children fed on condensed milk have less resisting power to disease.

The facts hereafter stated as to excess of diarrhœa occurring among infants fed on condensed milk must be considered in this connection. Owing to the statistical evidence as to the relation of condensed milk to epidemic diarrhœa and in view of the excessive disproportion of carbohydrates to fat in condensed milk and the liability to contamination after the tin is opened, some medical officers of health have taken steps through health visitors and others to discourage the use of even full cream sweetened condensed milk when the infant is fed artificially.

Medical men who have made a special study of the diseases of infants or of dietetics frequently insist that although sweetened full cream condensed milk may be a most useful food for babies for short periods it is not suitable for prolonged use. Louis Starr⁽²⁹⁾ said "Infants fed upon condensed milk though fat are pale, lethargic, and flabby, and though large are far from strong; have little power to resist disease; cut their teeth late, and are very likely to drift into rickets before the end of the first year." Cautley, Fowler, Hutchison, Pritchard, and Still all express a similar view which is perhaps put most emphatically by Pritchard⁽²⁴⁾ who says: "I have never yet seen an infant uninterruptedly fed for six months on condensed milk—which is, of course, milk which has been vigorously sterilised—who did not present unmistakable symptoms of rickets." In another place he suggests that the explanation may be overfeeding as "measured by the power of the particular infant to utilise its nutriment in a physiological manner," an excess of carbohydrates in the form of cane sugar being a frequent cause of this failure of metabolism. Several writers (Cautley, Hutchison, and Still) seem to look upon a deficiency of fat when associated with an excess of carbohydrates as a great factor in the causation of rickets. In this view rickets is especially liable to occur when the balance of the proportions of the various constituents of a food is seriously altered from that normally existing in breast milk.

Ashby and Wright⁽³⁰⁾ are apparently somewhat sceptical as to the production of disorders such as eczema, diarrhœa, constipation, rickets, and scurvy by the use of full cream condensed milk. They believe that, provided a reliable brand containing a full percentage of fat be selected, it may be substituted for fresh milk with advantage as a temporary resort. However, they also warn against the continuous use of condensed milk "or any form of preserved milk on account of the risk of scurvy."

It seems to be agreed that the administration of orange juice or some similar fresh vegetable substance will prevent the occurrence of scurvy.

It is the unhealthy and not the healthy children who are taken to specialists in diseases of infants, and a large number of children may possibly be fed continuously on condensed milk without showing any signs of injury from its use. Such healthy children are more likely to come under the observation of general practitioners than of consultants.

Scope of usefulness for infant feeding.

Most of the modern writers seem to agree that sweetened full cream condensed milk may often be used with advantage for short periods or on certain occasions. It is recognised that such condensed milk, when diluted according to the directions, can often be taken by very young babies when ordinary mixtures of fresh cow's milk disagree. Fowler considers it especially useful in cases where there is much vomiting. Hutchison found that "condensed milks do not clot with rennet at all or the resulting curd is much looser than in the case of fresh cow's milk."

Pritchard points out that the amount of caseinogen in cow's milk is larger in proportion to the lactalbumin and lactoglobulin than in human milk, and it is the caseinogen which is the indigestible element for young children, causing vomiting. In condensed milk the caseinogen appears to be altered in some way so that it is more digestible, almost like a peptonised milk. He believes, therefore, that condensed milk may be useful in tiding over the change from breast feeding to cow's milk, and thinks that the infant should be gradually accustomed to cow's milk by mixing a constantly increasing proportion of fresh cow's milk with the condensed milk mixture, until the child is able, without vomiting, to take cow's milk alone, owing to the gradual training of its power of digestion.

For such temporary use the authorities quoted above appear to see no harm in employing the sweetened variety of full cream condensed milk, but most of them specifically recommend the full cream unsweetened condensed milk in preference, subject to care being exercised that the milk is not kept too long after the tin is opened.

Instructions as to dilution.

Objections to the use of full cream milk for infants is largely based on the liability of such milk to be so diluted as to contain an insufficient proportion of fat, and the fact that the mixture made from sweetened condensed milk and containing as much fat as cow's milk would be so sweet that it would be objectionable.

A good deal has been written on the question of dilution, and the figures given by Pearmain and Moor⁽³⁵⁾ have been frequently quoted to show how hopelessly inadequate condensed milk is for infant feeding when used in the dilutions recommended on the labels. Although undoubtedly the fat percentage in diluted condensed milk is low compared with human milk, the figures referred to given an exaggerated idea of the poverty of the milk, as prepared in domestic circumstances according to the directions. The labels often direct that 14 parts of water are to be added to one of milk. Pearmain and Moor have taken this to mean proportions by weight, so that a condensed milk containing 10.5 per cent. of fat on dilution with 14 parts of water would only show 0.7 per cent. of fat. Allen⁽³⁶⁾ pointed out that the specific gravity of condensed milk was 1.28, and that the dilution is in practice effected by measure rather than by weight, and, making

these allowances, a condensed milk of 10·5 per cent. of fat would show 0·9 per cent. on dilution with 14 parts of water. But even this correction does not represent the actual state of affairs in household dilution; as Still, Fowler, and others have pointed out the domestic teaspoonful holds more than a drachm, and allowance has further to be made for the viscid milk which clings to the under surface of the spoon.

In illustration, Dr. Monier-Williams found that a particular teaspoon delivered on the average 6·3 grams of water, so that 14 teaspoonfuls weighed approximately 88 grams. The same teaspoon dipped dry into a sample of condensed milk of average consistency took up 17 grams of condensed milk. On this basis Brand "H" (p. 10) of the composition given by Pearmain and Moor would show the following results on dilution, supposing the same teaspoon to be used to measure out the milk and water.

Composition of Full Cream Sweetened Condensed Milk when Diluted by Teaspoon.

	Percentage of					
	Total Solids.	Proteins.	Fat.	Sugar.		Mineral matter.
				Milk.	Cane.	
Brand "H" Condensed Milk undiluted.	} 76·3	9·7	11·0	14·6	38·7	2·3
Diluted with 14 "parts" of water.	} 12·35	1·57	1·78	2·36	6·26	0·37
Diluted with 7 "parts" of water.	} 21·26	2·70	3·07	4·07	10·78	0·64

These figures show that a good quality of sweetened condensed milk, prepared for a young baby, by a mother who used a teaspoon measure and followed the directions of the manufacturer, would give a mixture, considerably deficient in fat as compared with human milk and containing an excess of sugar, but by no means constituting such a starvation diet as statements made by some observers would lead one to suppose.

As compared with fresh cow's milk, the 1 to 7 dilution, which is recommended for older children, would show a slight deficiency in fat, and a considerable excess of sugar.

I think that there has been some tendency to exaggerate the evil effects of feeding on full cream condensed milk, and that probably a considerable proportion of children may thrive tolerably well when fed even over prolonged periods with a high quality of condensed milk, diluted according to the directions given by the manufacturer as carried out by the ordinary mother or nurse, especially if care be taken to avoid this form of diet during the hot summer months on account of the danger of epidemic diarrhœa.

I believe, however, that fresh clean cow's milk in suitable dilution and mixture is more generally satisfactory for continued use.

Comparison with Pasteurised and other Milks.

Several medical authorities on infant feeding consider that for prolonged use pasteurised, sterilised, or dried full cream cow's milk is to be preferred to condensed milk. The tendency at present seems to be to consider boiling or sterilisation as preferable to pasteurisation. A considerable number of observers seem inclined to look favourably on dried milk, but with the proviso that sufficient experience has not been gained to show that it is safe for continuous use. With all these foods it is advised that due care should be taken to prevent scurvy by the addition to the diet of orange juice or some similar substance.

CONDENSED MILK IN GENERAL IN RELATION TO INFANT MORTALITY AND EPIDEMIC DIARRHŒA.

As far back as 1872 some medical men⁽³¹⁾ recorded their observations that children fed on condensed milk showed a tendency to succumb readily to diarrhœa which was not of severe type.

Several Medical Officers of Health have, in recent years, instituted statistical inquiries into the methods of feeding infants adopted in their districts, and have published figures showing the proportional number of babies fed on various foods who have died during the first year of life from different diseases and especially from epidemic diarrhœa.

Howarth⁽³²⁾ records the results of an inquiry conducted in Derby between November, 1900, and November, 1903, into the feeding of 8,343 infants.

The death-rate among the breast-fed babies represented in this number was 69·8 per 1,000, whilst the hand-fed children showed a death-rate of 197·5 per 1,000. Of the 1,626 hand-fed children, 895 had cow's milk and water only, and 149 were fed on condensed milk only. The infant mortality in the cow's milk group was 177 per 1,000, whilst in the condensed milk group it was 255 per 1,000, which was the highest rate of mortality for any method of feeding. The death-rate from epidemic diarrhœa is not given separately for infants fed on condensed milk; the rate for all hand-fed babies was 51·7 per 1,000, as compared with 8·6 per 1,000 for breast-fed babies. Dr. Howarth expresses the opinion that machine-skimmed condensed milk is absolutely unsuited for the food of infants, but he does not state what proportion of infants were fed on this variety; his figures apply, therefore, to condensed milk generally.

Newsholme⁽¹⁷⁾ analysed the figures obtained in Brighton from inquiries as to methods of feeding infants and as to deaths from epidemic diarrhœa during the three years 1903-5. Of 1,259 infants, 62·3 per cent. were breast-fed, 7·2 per cent.

received cow's milk only, and 3.1 per cent. were fed on condensed milk only. But of 121 infants dying from epidemic diarrhœa, only 6.5 per cent. were breast-fed, 36 per cent. had been fed on cow's milk, and 30.3 per cent. on condensed milk.

Newman⁽³³⁾, comparing diarrhœal mortality among infants fed with condensed milk and fresh cow's milk with the average mortality among all infants, from investigations made in Finsbury, came to the conclusion that "the mortality from diarrhœa amongst infants fed on condensed milk is nearly three times the average mortality in the first six months, whilst the mortality amongst those fed on cow's milk is less than twice the average. Between the sixth and ninth months condensed milk still gives a higher mortality, but the discrepancy is less marked."

Meredith Richards has for some years made inquiries at Croydon as to the relation of the method of feeding to infant mortality. In his Annual Report for 1908 he gives the figures for that year, which show that "diarrhœa is about seven times more prevalent among infants under six months of age fed on cow's milk than in those fed on the breast alone, while the incidence on infants fed on condensed milk is twice as high as on those fed on ordinary cow's milk, and 14 times as high as on the breast-fed."

These and similar inquiries indicate the serious liability to epidemic diarrhœa in infants fed on condensed milk. In the reports of some inquiries no differentiation is made between full cream and machine-skimmed milk, and it may possibly be the case that in some towns the evil results attributed to condensed milk may be partly due to the machine-skimmed variety. In future inquiries it would be desirable to differentiate full cream from machine-skimmed condensed milk, and in view of the considerations set forth on p. 33 as to the generic use of a particular name, it would be well to test the accuracy of information given as to brands, preferably by actual inspection of the tins.

ECONOMICAL CONSIDERATIONS: COMPARISON OF CONDENSED AND FRESH MILK.

The objections which are made to the use of condensed milk as a sole diet for infants no longer apply when it is a question of the use of the article as part of the food of an adult. The food value, expressed in calories, of sweetened full cream condensed milk is high, so that as soon as a child is old enough to be put on a mixed diet, condensed milk forms a suitable and nutritive food.

This applies also to machine-skimmed condensed milk when other fats are included in the dietary. This article contains sometimes as much as 10 to 12 per cent. of protein material along with 14 to 17 per cent. of milk sugar and 40 to 45 per cent. of cane sugar. Although the proportion of sugar is very high, such milk has very considerable nutritive value and the deficiency in butter fat may be made good by the addition to the dietary of some cheaper fat.

The food value of fresh skimmed milk (uncondensed) has been noted by Hutchison who compares the food value of a lunch consisting of 10 ozs. of bread and one pint of skimmed milk costing 2*d.*, with one of soup, beef, potatoes, turnips, bread, butter, and coffee costing 8*d.* He finds the fuel value in calories to be 925 in the case of the bread and skimmed milk lunch as compared with 940 in the mixed lunch costing four times as much.

When cost is considered quite apart from the question of convenience and portability, condensed milk, and especially the machine-skimmed variety, does not compare altogether favourably with fresh milk.

I purchased some samples of condensed milk in the White-chapel district. In the same shop sugar was on sale at 2*d.* per lb., and this is taken as the retail price of sugar. The cost of fresh full cream milk is taken at 4*d.* per quart and the fresh skimmed milk at $\frac{1}{2}$ *d.* a pint, which are ordinary prices in London.

Full Cream: A full cream milk of a well-known brand, sold at $5\frac{1}{2}$ *d.* for the so-called 1-lb. tin, was found to contain close on $14\frac{1}{2}$ ozs. of condensed milk. Assuming that the condensation was about the average, this would represent about $43\frac{1}{2}$ ozs. of original fresh milk. Assuming the cane sugar to be present in the proportion of 40 per cent., the milk would contain 5.8 ozs. The retail value of the condensed milk would then be:—

	<i>d.</i>
$43\frac{1}{2}$ ozs. of milk at 4 <i>d.</i> per quart....	4.35
5.8 ozs. of sugar at 2 <i>d.</i> per lb. ...	.72
	5.07

In this case the purchaser pays $5\frac{1}{2}$ *d.* for condensed milk, whilst he can get a corresponding amount of fresh full cream cow's milk and sugar for practically 5*d.*

Machine-skimmed: A well-known brand of Dutch machine-skimmed condensed milk cost 3*d.* for the so-called 1-lb. tin. The condensed milk contained in it weighed less than $13\frac{3}{4}$ ozs. A similar size tin of a popular brand, bearing the name of an Irish firm, but made in Lombardy, also cost 3*d.*, and contained even less milk.

Taking each to contain $13\frac{3}{4}$ ozs. and assuming that the sugar present was in almost the maximum amount (45 per cent.), the tin would contain 6.19 ozs. of sugar. Assuming that the condensation had been carried so far that the condensed milk was one-third of the original, it would correspond to 41.25 ozs. of milk. The retail value of the contents would be:—

	<i>d.</i>
41.25 ozs. skimmed milk at 1 <i>d.</i> per quart ...	1.03
6.19 ozs. sugar at 2 <i>d.</i> per lb. ...	.77
	1.80

These figures show that a purchaser of machine-skimmed condensed milk at 3*d.* could obtain the same food value in the shape of fresh skimmed milk and sugar for slightly over 1 $\frac{3}{4}$ *d.*, thus effecting a saving of nearly 5*d.* in each 1*s.*

Mr. James Long, in his evidence before the Select Committee on Food Products Adulteration, put the case a little more strongly, stating that the amount of separated milk represented in a 3*d.* tin of machine-skimmed condensed milk was only worth a $\frac{1}{2}$ *d.* and the sugar a $\frac{1}{2}$ *d.*, giving a total of 1*d.* He, however, was taking the cost of separated milk at the farm as 1*d.* to 1 $\frac{1}{2}$ *d.* per gallon. The figures I have given above represent the cost at the present time to an actual purchaser in a town.

V.—STATEMENTS MADE ON LABELS AND ADVERTISEMENTS IN REGARD TO INFANT FEEDING AND OTHER MATTERS: THEIR ACCURACY AND EFFECT.

The considerations put forward in the preceding chapter as to the injurious results of feeding infants on condensed skimmed milk render it necessary to examine carefully the statements made on labels and advertisements; to observe how far such statements are accurate or misleading, and how far they tend to encourage an undesirable or even dangerous practice.

In addition to the picture or design denoting the brand, labels of condensed milk bear other printed matter, some placed thereon in order to comply with the law and some for the trader's own purposes. Condensed machine-skimmed milk must bear three declarations:—

- (1.) The words "Machine-skimmed Milk" must appear "printed in large and legible type" to conform to the requirements of Sections I. and XI. of the Sale of Food and Drugs Act, 1899.
- (2.) A declaration must be made of the added sugar in accordance with Section 8 of the Sale of Food and Drugs Act, 1875.
- (3.) (If made abroad) under the Merchandise Marks Act the origin must be declared.

Conditions (2) and (3) apply also to sweetened full cream milk.

An examination of the labels of 109 different brands of condensed machine-skimmed milk shows that those manufactured in a foreign country have the fact stated on the label. In regard to (1) the words "machine-skimmed" appear somewhere or other on all the labels, but on some they are arranged to be as little conspicuous as possible without too obviously contravening the condition as to "large and legible type." In some cases the words are printed at right-angles to the name of the brand, so that the tin must be turned horizontally to read them; or the colour of the print or of the background are such as not to let the words strike the eye too readily. Sometimes the words "Condensed Milk" are printed in very large type, whilst the words "machine-skimmed" are much smaller.

A considerable number of labels—63 out of 109—bear the words “Condensed Machine-skimmed Milk” or some variation, such as “Condensed Milk, Machine-skimmed” on the principal or design part of the label. The other 46, however, relegate the declaration to one side or the other; the centre or principal part containing a picture or design and the words “. . . Brand,” or “. . . Condensed Milk,” or “. . . Milk.” When such milks are exposed for sale in shop windows the tins are so arranged that only the design part of each can be seen from outside. In the same window or elsewhere in the shop may be exhibited a large show-card advertising the particular brand, and on these show-cards the words “machine-skimmed” are nearly always omitted, the name of the brand and the price alone being mentioned. Thus in the window of a shop in the Bethnal Green district a large number of tins of condensed milk were arranged so that the design part of the label alone was visible from the street. Above the collection of tins was a placard bearing the words—

“ . . . Milk,
“2½d. a tin.”

Although on the hidden part of the label the words “machine-skimmed” appeared, it can scarcely be said that the purchaser received proper warning by the declaration; it is likely that many poor people buy such milk in ignorance of its inferior quality, and perhaps never read the small print at the sides of the label.

The declaration as to added sugar is almost universal, being present on every one of the 109 labels of machine-skimmed condensed milk. However, I have labels of two different brands of condensed sweetened full cream milk which bear no statement as to sugar, although cane sugar is present in each to the amount of nearly 40 per cent. In many instances the declaration of added sugar is made in a very inconspicuous fashion, and in no case is it calculated to inform the ignorant purchaser that practically two-fifths of the contents of the tin are sugar. One label bears the words “Prepared with Sugar” surcharged in red diagonally across the printed matter of the label. It is easy to overlook such a declaration without very careful scrutiny. Perhaps the clearest declaration is one something like the following: “This tin contains machine-skimmed condensed milk. Preserved with refined sugar.”

Declarations Bearing on Infant Feeding.

Some years ago certain brands of condensed “skimmed” or “separated” milk bore statements on the labels recommending them for the feeding of infants,* and even where such direct statements were not made the labels of some brands gave directions for dilution for infants.

* British Medical Journal, 1895, 2, p. 232.

As far as I can ascertain, no brands of machine-skimmed milk are now sold in this country bearing any such explicit statement. On the contrary, I find that 27 out of 109 different brands bear a declaration on the label that the milk is not suitable for infants. It is to the credit of the manufacturers that on some labels this statement is clear and definite and not surrounded with other reading matter in such a way as to obscure the meaning. For instance, one importing firm has three brands which under "Directions for use" state "This milk is *not* suitable for the use of Infants or Invalids." Another label bears in a similar position the words "Should not be used for Infants." Other declarations are not as explicit. The most frequently employed is as follows:—"This milk is specially adapted for use with Tea, Coffee, and Cocoa, but is not recommended as food for Infants." This, with a slight modification in two cases, occurs on the labels of eleven different brands, whilst another adds at the end the words "who cannot eat bread and butter and similar food." Four brands bear a similar declaration, viz.: "This milk is specially adapted for use with Tea, Coffee, and Cocoa, but not as Sole Food for Infants." One brand has the following:—"SPECIALLY ADAPTED for use with TEA, COFFEE, and COCOA, but NOT for INFANTS' or INVALIDS' FOOD." Another brand states "Owing to absence of fat this milk is incomplete as a food for infants."

Advertisement of Full Cream Brands on Labels.

Some labels bear in small type the words "but not recommended for infants who cannot eat bread and butter or other fats," followed by a recommendation of a brand of full cream milk made by the same firm. The minute size of the statement as to unsuitability for infants, along with the recommendation of other brands, is likely to lead to misunderstanding. On one label occur the words "For Infants and Invalids we recommend the use of our full cream milk," after a not very prominent notice as to unsuitability. The words "for infants and invalids" are in much larger type than the previous declaration; the names of the brands of full cream milk recommended are in small type and are further obscured by the name of the manufacturer printed across in red, partially obliterating them. This might mislead mothers into thinking the declaration to be an actual recommendation, for infant feeding, of the milk in the tin.

It must further be remembered that for mothers of the class who so frequently give solid food to their babes, the qualifying words "who cannot eat bread and butter" are liable seriously to diminish the effect of the warning against the use of the milk for infant feeding. Where no warning is given against using machine-skimmed milk for infants the use of the label for advertising a full cream variety is still more likely to mislead an ignorant or careless reader. The following is an example:—"IMPORTANT. For infants' food try our . . . BRAND Condensed Milk, which is a guaranteed full cream milk prepared with pure cane sugar only. *This milk is generally recommended by eminent doctors.*" This paragraph, and especially the last part, which I have put in italics, may easily mislead people to

imagine that the recommendation refers to the milk in the tin bearing the label, and especially as the full cream brand recommended is rarely obtainable at the retail shop selling the machine-skimmed variety.

Words "*Machine-Skimmed*."

One curious point which came out in the course of my enquiries was that when the words "machine-skimmed" are boldly and prominently displayed some poor people actually take them to indicate a specially high quality of the milk. One woman told me she thought the words indicated that the milk had been treated by machinery and not touched by hand, and that it was therefore specially pure. Another said she did not know exactly what the words meant, but she had always thought that the milk in the tin was "the thick rich milk from the top!" Such ignorance serves to explain why some poor mothers, although actuated with the best intentions, feed their babies on machine-skimmed milk. Many of them seemed to know that "skim milk" was an impoverished milk, but the words "machine-skimmed" did not convey the same impression. Probably the thick rich appearance due to condensation and added sugar tends to maintain these misconceptions.

OTHER WORDING LIABLE TO MISLEAD.

Where no indication of unfitness for infant feeding is given, the following wording is liable to give the impression that the machine-skimmed milk may be used for babies—"by the addition of a little water to reduce it to required consistency, it may be used for almost every purpose for which ordinary machine-skimmed milk is used." Misunderstanding of the true quality of the milk is also apt to arise when the words "machine-skimmed" are made somewhat unobtrusive and the label bears the following or similar declaration—"This tin contains condensed milk with the addition of refined sugar," &c. The tin does not contain condensed milk, but condensed skimmed milk, which is a very different article.

Certain labels of full cream milk bear words likely to give an erroneous impression of special richness in milk fat. Some bear the words "Owing to the *great richness* of this *preserved cream milk*" whilst the milk is only an ordinary full cream milk. Another label, after giving directions for use, adds "if less water be added it may be used instead of cream," whilst another manufacturer boldly calls his product "evaporated cream." This particular article has been criticised in the Reports of the Principal Chemist of the Government Laboratory for the years 1902 and 1908.

FREEDOM FROM BACTERIA.

Many brands bear statements calculated to impress purchasers with the great care taken in the preparation of the milk so as to secure its purity and freedom from bacteria. The following are examples:—

- (1.) "The process of preserving and condensation and its reliable source, render it absolutely incapable of transmitting

the germs of typhoid fever, scarlet fever, diphtheria, and other diseases, thereby proving its superiority over ordinary skimmed milk."

(2.) "This machine-skimmed milk is absolutely pure, and free from any foreign substance but the best cane sugar."

The labels of certain brands of machine-skimmed condensed milk, not sold in England, but intended for export to foreign countries, have wording such as the following:—

(3.) "This milk, prepared from the best cows' milk on the richest pastures of Holland, is absolutely free from bacteria and all noxious germs, and excels in every respect the fresh milk."

Several brands of full cream milk sold in this country have very definite statements as to freedom from bacteria. One bears almost exactly the same wording as in (3) above. Another states—

(4.) "Being prepared on sanitary principles by the particular process the milk is made easy of digestion, and the germs of disease which are frequently found in fresh milk are destroyed."

(5.) "This condensed milk is specially prepared from the finest full cream cows' milk, pasteurised in order to destroy all germs and bacilli, and preserved with pure refined sugar."

(6.) "For Infants' food is superior to the purest uncondensed milk, being absolutely uniform in quality and not liable to turn sour. The process of preserving and condensation, and its reliable source, render it absolutely incapable of transmitting the germs of disease, thereby proving its superiority over the natural fresh milk."

(7.) Another label contains the words "being free from bacteria and other noxious germs."

(8.) "This milk . . . is absolutely free from bacteria and all noxious germs and excels in every respect ordinary milk."

(9.) " . . . milk, being perfectly sterilised, is positively safe for infant feeding."

(10.) " . . . milk is pure rich milk condensed without the addition of sugar or any other substance, and is guaranteed absolutely free from bacteria."

(11.) "It is condensed and sterilised by a new process, it contains no injurious germs, and retains all its cream."

(12.) "Pure sterilised Swiss milk."

The considerations put forward in Chapter II. indicate that such statements as the above are not entirely justified by the facts. As mentioned on page 24 the evidence at present indicates that the condensing process may probably destroy the germs of certain infectious diseases, but does not support pronouncements suggesting the absence of bacteria in condensed milk. The investigations conducted by Dr. Gordon and Mr. Elmslie, as reported in Appendix II., were on samples of milk bearing statements such as are given above. In no single instance was the milk found sterile. One milk, which was claimed to be absolutely free from bacteria, showed a very high proportion of

organisms capable of growing on gelatine or agar. Even unsweetened full cream milks, which had been presumably subjected to a process of sterilisation after the filling of the tins, were not germ free. Two of these—"N" and "O" contained a large number of organisms; in two others, "F" and "G," the bacteria were comparatively few.

PICTURES AND DESIGNS.

The appearance and wording of the main portion of the label may have a definite misleading effect on the minds of ignorant persons, and on the subject of condensed milk there is great ignorance amongst many poor people. Some seem to be of opinion that all condensed milk comes from Switzerland. Others think that all Swiss milk is goats' milk.

Certain pictures on labels are liable to give a false impression. From the evidence which has come before me, one of those most frequently bought under a wrong impression is the "Goat" brand. On the centre part of the label is the picture of a goat being milked by a girl. In large letters at the top is the word "Goat"; underneath is "condensed," and in large letters "Machine-skimmed milk." On the flank of the goat in the picture is the word "brand" in small letters. My inquiries indicate that this milk has been largely used in London for infant feeding. I found that in the East End there was a belief that when breast feeding was impracticable, goats' milk was the best substitute. Several women informed me that they bought this brand believing it was actually milk from goats, and some refused to believe that it was cows' milk. One said the picture of a goat on the label would not be allowed if it was not really goats' milk. Shopkeepers and their assistants informed me that purchasers frequently ask for "Goats' milk." One corrected a woman and suggested that she meant "Goat brand" milk; she replied "No, goats' milk." One shopkeeper informed me that so positive were some mothers that this milk was from the goat, and specially good for their babies, that on one occasion when he was able to offer full-cream milk at the same price in tins only slightly smaller, it was refused, although he pointed out that one was skimmed milk whilst the other contained the fat which was of so much value in infant feeding. On the entire label of this particular brand there is not a word to indicate that the milk is cows' milk, nor that it is unsuitable for infant feeding.*

Show Cards and Advertisements.

The provisions of Section 11 of the Sale of Food and Drugs Act, 1899, requiring the use of the words "machine-skimmed" milk on labels of tins of condensed separated milk, do not apply

* Since this was written I have seen a specimen of a new label issued for this brand, which, while retaining the general design, declares "This tin contains machine-skimmed cows' milk with nothing added but the finest sugar." It also contains a statement that the milk is not recommended for infants, and a recommendation of a full-cream brand as a suitable food for infants.

to show cards or advertisements. Several firms provide retailers with attractive coloured show cards to hang up in their shops in order to attract customers. In no instance have I seen such a card bearing any warning that the milk advertised was unsuitable for infant feeding, and in only one case was there any indication that the milk referred to was machine skimmed; while on some cards the statements or their pictorial accompaniments appear to be distinctly misleading.

VI.—CONCLUSIONS AND ADMINISTRATIVE CONSIDERATIONS.

Review of the foregoing chapters leads to the conclusion that it is desirable in the interests of public health and of the consumer, that certain requirements should be fulfilled in addition to those which at present result from the provisions of the Sale of Food and Drugs Acts, or can be insisted upon by sanitary authorities. The requirements which appear to me of principal importance are stated in the headings below. These requirements are applicable equally to dried milks, milk powders, uncondensed sterilised milks in sealed tins and similar products.

(1.) PREVENTION OF THE USE OF CONDENSED SKIM MILK FOR INFANT FEEDING.

With this object, tins of condensed skimmed milk might be required to bear in letters of prescribed size (making due allowance for the size of the tin) the words "SKIMMED MILK—UNFIT FOR INFANTS." Such a declaration should be placed on some prominent part of the label, and should be entirely separate from any other reading matter. It would also be advisable, in order to eliminate one of the possibilities of misconception, to consider the prohibition of the advertising on the label of a machine-skimmed milk of a brand of full-cream milk. Some firms already put a statement on the labels of their machine-skimmed milk that the product is not recommended for infants; but the warning is in small type on an obscure part of the label, or associated with words advising the use of certain full-cream brands of the same maker (Chapter V.). All these things tend to confuse the purchaser and to lead to failure to recognise the real meaning of the warning. Whatever is done, it is probable that some parents would still fail to understand how unsuitable are these milks deprived of fat for feeding babies, but a clear declaration could not fail to have some effect in educating them to know that all condensed milks are not alike in composition; it would also materially assist the efforts of medical men, nurses, health visitors, and others, in impressing upon mothers the danger of such foods, if they could point to a definite declaration on the tin itself of the unsuitability of the food.

In order to prevent the re-introduction of partially skimmed milk for infant feeding, it would be advisable to require the

warning against the use for infant feeding to appear on the labels of all except full-cream milks.

(2.) PROHIBITION OF THE USE OF ANY PRESERVATIVE, EXCEPT SUGAR, IN CONDENSED MILK.

The use of preservatives, even in small proportions, in articles intended for the feeding of infants is objectionable, inasmuch as (1) children of tender age are very susceptible to the action of poisonous drugs, and (2) their sole food being milk, fresh doses of the drug introduced at each meal would lead to the infant soon receiving an injurious amount. Even in the case of milk intended for manufacturing purposes the use of preservatives is unnecessary; their employment is probably intended to relieve the makers from the duty of taking the necessary precautions, at every stage of the manufacture, to exclude dirt; and in view of the large extent to which the consumer is at present dosed with preservatives in other foods without his knowledge, it would seem unnecessary to subject him to the possibility of receiving boric acid, or formalin, in chocolates, confectionery, &c., made with condensed milk.

In their circular of the 11th July, 1906, the Board put forward the views expressed by the Departmental Committee on Preservatives and Colouring Matters in Food to the effect that no preservatives should be allowed in milk, and suggested action to local authorities under the Sale of Food and Drugs Acts. If preservatives are not to be allowed in fresh milk, it would seem reasonable to prohibit their use in condensed milk also.

By far the majority of condensed milks at the present time are free from chemical preservatives. There would appear to be no hardship, therefore, in prohibiting preservatives entirely, with the exception of sugar. The varieties of condensed milk most frequently found to contain preservatives are full cream milks, imported from Italy or France in large tins (*see* p. 19); they contain an exceedingly small proportion of cane sugar, and the evidence I have received goes to show that they are used by blended butter. It would seem to the public advantage to restrain such practices rather than to facilitate them by permitting the use of preservatives.

(3.) CONTROL OVER TRADE STATEMENTS LIABLE TO MISLEAD THE PURCHASER AS TO THE CHARACTER, FOOD VALUE, OR WHOLESOMENESS OF THE PRODUCT SOLD.

Evidence has been given above that such statements are sometimes inaccurate or, at least, misleading (Chapter V.). This is a matter over which public authorities at present can exercise little or no control. There would be advantage if public health authorities were in a position to require the withdrawal from sale of all tins of condensed milk considered, after due inquiry, to be labelled or advertised in a false or misleading manner liable to

lead to injury to public health. Similarly, it would be advantageous to be able to enforce the withdrawal from use or circulation of show cards and advertisements containing misleading or inaccurate statements.

(4.) DECLARATION OF THE CONTENT OF MILK FAT AND OF ADDED SUBSTANCES FOREIGN TO MILK.

At the present time, owing to the difference in amount of fat in the original milk and to differences in extent of condensation, full cream condensed milks may vary very considerably in value. Some have been found to contain 13 per cent. of fat, whilst others have been found as low as 8.5 per cent. (or less) without the analyst being able to classify them definitely as made from impoverished milk. The purchaser, therefore, has no guarantee except the reputation of the maker as to the food value of the milk he is buying, and there are considerable variations even in the milk of the same manufacturer at different times.

In order that the purchaser might have some definite facts to assist him in deciding as to the value of a particular milk for infant food, it would appear desirable that on the label of each tin should appear a declaration as to the amount of fat. Thus, tins might bear a declaration, in type of approved size, "this milk contains not less than (—) per cent. of milk fat," leaving the manufacturer to insert such a figure as he could be sure of maintaining. This seems preferable to the plan of fixing a low minimum and requiring this to be maintained in all cases. A low minimum standard would probably tend to a gradual deterioration of all condensed milk to that level. A high minimum would cause hardship to manufacturers, say, in Holland, who declare that their cows give milk so poor in fat that they cannot reach a high level. The manufacturer able to produce a milk containing a high percentage of fat would no doubt secure a higher price from such purchasers as were willing to pay extra for the richer milk, whilst others would obtain prices in accordance with the richness of their product.

Substances present in condensed milk which are foreign to milk are already, in a sense, required to be declared by Section 8 of the Sale of Food and Drugs Act, 1875, but it is desirable that steps should be taken to secure that the declaration should be more explicit, for example by requiring cans, packages, or other receptacles to bear in letters of prescribed size (making due allowance for the size of the package) such words as "this milk contains not more than 30, 35, or 40 per cent. (as the case might be) of added sugar" (or other foreign material).

(5.) IDENTIFICATION OF RESPONSIBLE MANUFACTURER OR DEALER.

The suggestion has frequently been made and appears to be important that the public authorities responsible for control over the purity of the articles here in question should be able to ascertain the name of the manufacturer, the importer, or the person responsible for putting on the market a particular brand of condensed milk. Already, in many cases, tins bear the name of the manufacturer, or those responsible for the sale of the milk, but in other

cases no name appears on the tins. In opposition to the proposal to make obligatory such marking traders represent that they would be prejudiced if the manufacturer's name were required to appear on the labels in all cases, and consider such a course unnecessary if the control desired can be otherwise obtained.

Some arrangement might be devised for systematic marking of the tins so as to indicate the manufacturer or person responsible, and in connection with any such arrangement there might be advantage in arranging the marks in such a way as to indicate the approximate date of canning. One firm already carries this out by slight pricks or indentations on the top of the tin; when a key, made of cardboard, is placed on the top of the tin, the position of the marks shows the approximate date of canning. It is obvious that a mark on the tin itself would be more reliable than a printed mark on the label.

I think some method of this kind would be of use, and would benefit the trade as much as the public. It would tend to prevent retailers selling off new stock and retaining the old, possibly until the tins become blown, and then claiming their value from the manufacturer. At the same time, in the event of some occurrence necessitating a special inquiry, a method of fixing, approximately, the date of canning of particular tins might lead to useful information in the public benefit.

F. J. H. COUTTS.

ADDENDA.

- (1.) REGULATIONS IN OTHER COUNTRIES IN REGARD TO CONDENSED MILK.
- (2.) REPORT BY DR. M. H. GORDON AND MR. R. C. ELMSLIE ON A BACTERIOLOGICAL INVESTIGATION OF SOME SPECIMENS OF CONDENSED MILK.
- (3.) REFERENCES.

ADDENDUM I.

REGULATIONS IN OTHER COUNTRIES IN REGARD TO CONDENSED MILK.

My information is to the effect that in most European countries machine-skimmed condensed milk is rarely used, so that no special legislation has been found necessary.

In *Switzerland* regulations made on the 29th of January, 1909, under the "Loi fédérale sur le commerce des denrées alimentaires et de divers objets usuels" (8th December, 1905), requirements are laid down thus:—

Article 22.—Les conserves de lait doivent être désignées de telle manière que l'on puisse reconnaître quelle sort de lait (lait entier ou lait écrémé) a été employée pour leur fabrication et quelles sont leurs autres parties constituantes. Elles ne doivent pas renfermer d'agents conservateurs, à l'exception du sucre."

India.—A considerable quantity of machine-skimmed condensed milk is exported from Europe to India and other places in the East. I have seen copies of correspondence between officials in India and Burma and certain trading firms which indicate that steps have been taken to ensure that the labels on tins of condensed skimmed milk imported into those countries are clearly marked so as to distinguish such milk from full cream condensed milk. The desirability of insisting on all tins of condensed skimmed milk bearing a warning against the use of such milk for feeding infants has been suggested in India, but no legislation giving effect to it appears to exist.

South Africa.—Condensed or dried milk prepared from skimmed or separated milk is, I am informed, practically excluded by the tariff imposed under the South African Customs Convention. Whilst a duty of 2*d.* per lb. is charged on full cream condensed, dessicated or preserved milk or cream, a duty of 6*d.* per lb. is required on the skimmed or separated varieties.

Trinidad.—The Board of Health have decided to ask the Government to raise the standard for condensed milk to 9 per cent. milk fat and to put a prohibitive duty on any milk below that standard.

Cuba.—Sanitary ordinances published in the official Gazette of January 12th and February 27th, 1906, have had, I am informed, the effect of stopping the importation and sale of condensed skimmed milk.

Article 85 prohibits the sale of watered, skimmed, or adulterated milk.

Article 86 states that milk is adulterated if the whole or a portion of the cream has been abstracted.

Article 106 prohibits the introduction, warehousing or sale of "adulterated" condensed milk. Condensed milk is defined as adulterated if the amount of butter fat is less than 25 per cent. of the solid matter contained in it or if some foreign substance has been added, besides the sugar used for conservation.

United States.—Circular No. 19 (dated 26th June, 1906) of the Department of Agriculture, supersedes Circular No. 13 of the 20th December, 1904, and lays down the following among the standards of purity for food products.

B.—Milk and its Products.

6. *Condensed Milk, Evaporated Milk*, is milk from which a considerable portion of water has been evaporated and contains not less than twenty-eight (28) per cent. of milk solids of which not less than twenty-seven and five-tenths (27·5) per cent. is milk fat.

7. *Sweetened Condensed Milk* is milk from which a considerable portion of water has been evaporated and to which sugar (sucrose) has been added and contains not less than

twenty-eight (28) per cent. of milk solids of which not less than twenty-seven and five-tenths (27.5) per cent. is milk fat.

8. *Condensed Skim Milk* is skim milk from which a considerable portion of water has been evaporated.

The Sanitary Code of the Board of Health for the City of New York, adopted April 22nd, 1908, forbids (Sec. 55) the introduction or sale of "adulterated" condensed milk. The term "adulterated" refers to condensed milk in which the amount of fat is less than 25 per cent. of the milk solids or to which any foreign substance whatever has been added, excepting sugars.

Condensed skimmed milk is allowed to be brought into New York for manufacturing purposes only, if offered for sale or sold only in forty-quart cans coloured bright blue and bearing the words "Condensed Skimmed Milk" in such form as directed by the regulations of the Board of Health.

Jamaica.—Section 9 of the Adulteration of Foods Law, 1908, runs thus:—

"Every tin or other receptacle containing condensed separated or condensed skimmed milk must bear the label 'Machine skimmed milk, unsuitable for feeding infants' as the case may require, printed in large and legible type, and if any person sells or exposes for sale condensed separated, or skimmed milks in contravention of this section, he shall be guilty of an offence, and be liable to a penalty in such case not exceeding twenty pounds."

Canada.—From an Appendix to Bulletin No. 208 (May 26, 1910) giving the results of analyses of condensed milk in the laboratory of the Inland Revenue Department, Ottawa, it appears that the standards officially adopted in Canada for the purposes of the Adulteration Act are as follows:—

6. *Evaporated Milk* is milk from which a considerable portion of water has been evaporated, and contains not less than 26 per cent. of milk solids, and not less than 7.20 per cent. milk fat.

7. *Condensed Milk* is milk from which a considerable portion of water has been evaporated, and to which sugar has been added. It contains not less than 28 per cent. of milk solids, and not less than 7.7 per cent. of milk fat.

8. *Condensed Skim Milk* is skim milk from which a considerable portion of water has been evaporated with or without the addition of sugar.

2. *Skim Milk* is milk from which a part or all of the cream has been removed and contains not less than eight and one half (8.50) per cent. of non-fat, milk solids.

Commonwealth of Australia.—Regulations dealing with condensed milk were made in Victoria on 7th November, 1906 (under the Pure Food Act, 1905), in South Australia on 18th May, 1910 (under the Food and Drugs Act, 1908); and in New South Wales on 11th May, 1910 (under the Pure Food Act, 1908). A

Departmental Conference representing the Commonwealth Government, New South Wales, Queensland, South Australia, Victoria, and Tasmania, has recently (1910) recommended a series of definitions and "pure food" requirements for adoption throughout the Commonwealth. Presumably the Regulations framed by Victoria, South Australia, and New South Wales, above referred to, will be altered where necessary to accord with the suggested Regulations. Those relating (a) to the general requirements as to labelling of foods, and (b) to the specific requirements regarding condensed and dried milks are as follows:—

(a.) EXTRACT FROM GENERAL REGULATIONS.

1.—LABELS.

Meaning of the word "Label."

(1.) The term "statement" or "label" shall mean any written, pictorial, or other descriptive matter, written on or attached to any package containing a food or drug for sale.

Principal Label.

(2.) The principal label shall be that which fully describes the article, and which is written in the most prominent types, and which is attached to the immediate container so that it cannot easily be removed; there shall be no other label accompanying the article as prominent as the principal label aforesaid.

Contents of the Principal Label.

(3.) The contents of the principal label written on or attached to any article of food or drug for sale shall include the following particulars:—

(1.) The name of the substance or product.

(2.) In case of compounded, mixed, or blended foods, words which indicate that the contents are compounded, mixed, or blended, together with the words "imitation," "compound," or "blend," as the case may require.

(3.) Statements of ingredients, and of derivatives or preparations of ingredients required to be declared, and of the quantity or proportion in which they are present; statements of the nature of any extraneous substance of which the presence is required to be declared (such as permitted preservative, harmless colouring matter and flavouring); statements of the net weight or volume of the contents of any package; and any necessary statement regarding grade or quality. The statements mentioned in this paragraph shall appear together in the principal label within a panel having a light-coloured ground enclosed by a line, in bold-faced sans-serif capital types of not less size than six points face measurement.

- (4.) Such other information as may be required.
- (5.) Name of manufacturer or importer, if required to be given.
- (6.) Place of manufacture or country of origin, if required to be given.
- (7.) Such other trade information, or directions for preparation or use as the manufacturer or agent may wish to add.

Descriptive Matter on Labels.

(1.) The trade name or description, and descriptive matter, written on the statement or label attached to any package which contains a food or drug, or any substance intended to be used, or which may be used as an addition to a food or drug, shall not contain any statement, claim, design, device, fancy name, or abbreviation which is false or misleading in any particular concerning the articles, or the ingredients or substances contained therein, or concerning the quality, or the place of origin of the said ingredients or substances.

(2.) Descriptive matter written on or attached to a package which contains any food or drug shall not include any comment on, reference to, or explanation of, any statement or label required by the Act or by the regulations to be written on or attached to any package containing a food or drug, which, directly or by implication, contradicts, qualifies, or modifies such statement, or the contents of such label.

(b.) EXTRACT FROM REGULATIONS AND STANDARDS IN REGARD TO MILK.

Condensed or Concentrated Milk.

28.—(4.) Condensed or concentrated milk shall be milk condensed or concentrated by the evaporation of a portion of its water content.

Unsweetened Condensed or Concentrated Milk.

(5.) Unsweetened condensed or concentrated milk shall contain not less than twenty-one and two-tenths parts per centum of milk solids not fat and eight parts per centum of milk fat. It shall not contain any foreign substance.

Sweetened Condensed Milk.

(6.) Sweetened condensed milk shall contain not less than twenty-five and five-tenths parts per centum of milk solids not fat and not less than nine and nine-tenths parts per centum of milk fat. It shall not contain any foreign substance save sugar.

Labelling.

(7.) There shall be written in the principal label attached to every package which contains any condensed or concentrated

milk, directions for making with its contents milk of composition at least equal to milk as standardised by paragraph (1) of this Regulation,* in the following form:—

To make milk not below the Commonwealth standard add (*here insert the number of parts*) parts of water by volume.

Provided that the presence of sugar in the contents of any such package when diluted in accordance with such statement shall not be deemed to constitute a contravention of this Regulation.

Condensed Skim or Separated Milk.

(8.) Condensed skim or separated milk shall be skimmed or separated milk from which a considerable proportion of water has been evaporated. It shall contain not less than twenty-six and four-tenths parts per centum of milk solids not fat; it shall contain no foreign substance.

Labelling.

(9.) There shall be written in the principal label attached to every package which contains any condensed skim, or separated milk, the words "Condensed Skim Milk, unfit for infants," in bold faced sans-serif types, of not less size than twelve points face measurement; the said words shall form the first words of the principal label, no other words shall be written on the same line or lines. Additionally, there shall be written across the face of the whole of the principal label, in a diagonal line in a transparent red colour, the words "Skim Milk" in bold-faced sans-serif capital types of not less size than forty-eight points face measurement.

Dried Milk.

29.—(1.) Dried milk shall be milk from which the water has been removed by a process of heating, and without the addition of any foreign substance. When it is dissolved in or treated with water in the proportion set out in any label accompanying it, the resulting liquid shall conform with the Commonwealth standard for milk with respect to total solids and milk fat.

Labelling.

(2.) There shall be written in the principal label attached to every package which contains any dried milk, directions for making with its contents milk of composition at least equal to milk as standardised by paragraph (1) of this Regulation, in the following form:—

"To make milk not below the Commonwealth standard add (*here insert the number of parts*) parts of water by volume."

* *i.e.* not less than 12 per cent. total solids; 3.3 per cent. fat; 8.5 per cent. other solids.

Dried Skim Milk or Separated Milk.

30.—(3.) Dried skim milk or dried separated milk shall be skim milk or separated milk from which the water has been removed by a process of heating, and without the addition of any foreign substance. When it is dissolved in or treated with water in the proportion set out in any label accompanying it, the resulting liquid shall conform to the standard of skim milk or separated milk.

Labelling.

(4.) There shall be written in the principal label attached to every package which contains any dried skim milk or dried separated milk the words "Unfit for Infants" in bold-faced sans-serif types of not less size than twelve points face measurement. The said words shall form the first line in the principal label, and no other word shall be written on the same line or lines. Additionally there shall be written across the face of the principal label in a diagonal line in a transparent red colour, the words "Skim Milk" in bold-faced sans-serif capital letters of not less size than forty-eight points face measurement.

ADDENDUM II.

REPORT BY DR. M. H. GORDON AND MR. R. C. ELMSLIE ON A
BACTERIOLOGICAL INVESTIGATION OF SOME SPECIMENS OF
CONDENSED MILK.

Samples of fifteen different brands of condensed milk were received, each separate brand being marked with a letter (A to O). Five consisted of full-cream sweetened milk, four of full-cream unsweetened milk, and six of machine-skimmed sweetened milk.

Objects of the Investigation.

The investigation aimed primarily at testing the accuracy of the statement made by certain manufacturers that their condensed milk is free from bacteria.

When it became clear that this statement was inaccurate, the investigation was extended in order to determine the nature of some of the organisms present, and particularly to determine their probable source. Whether, for example, some of these organisms had been present in the original milk and had escaped destruction in the process of condensing.

Method.

Considerable difficulty was found in working with the milk owing to its viscosity. The following method was ultimately adopted:—

The flat surface of the tin was scrubbed with soap and water and ether. It was then flooded with 5 per cent. mercuric chloride

solution for 10 minutes. This was washed off with sterile water, replaced with ammonium sulphide solution, and the latter in turn washed away.

The tin was then opened with a sterile metal tin-opener along a line about $\frac{1}{2}$ inch from the rim and the lid turned back. About 10 grammes of the milk was immediately withdrawn by a sterile glass pipette from the depth and placed in a weighed sterile flask. The weight of milk was determined and a solution was made by the addition of sterile water so that 1 gramme of milk was contained in 5 c.c. of the solution. From this solution further dilutions were made and the culture media inoculated in the usual way. The quantities used in making cultures are therefore given in grammes or parts of a gramme.

The tests carried out were:—

1. Total colonies on gelatine plates incubated for 3 days at 20° inoculated with .01 and .001 gramme.
2. Total colonies on agar plates incubated for 3 days at 37° inoculated with .01 and .001 gramme.
3. Phenol broth (.5 per cent.) grown anaerobically at 37° for the presence of streptococci (1, .1, .01 gramme).
4. Glucose bile salt broth } at 37° for organisms of the
5. Lactose ,, ,, } bacillus coli group (1, .1, .01 gramme).
6. Litmus milk, heated to 80° for 10 minutes and incubated anaerobically at 37°, for spore bearing anaerobes (1, .1 .01 gramme).

Micro-organisms were isolated:—

1. From the original agar plates.
2. By plating out the phenol broth tubes on agar.
3. By plating out the glucose or lactose bile salt tubes on neutral red bile salt lactose agar (rebipelagar).

The results of the tests are set out in Table I.

The organisms recognised in the growth from the various samples of milk are set out in Table II.

As far as possible all streptococci, staphylococci, coliform bacilli, and other gram-negative bacilli, which might possibly belong to the bacillus coli communis group, were isolated and tested further.

Results.

Sterility.—None of the specimens tested proved to be sterile. There was a very great variation in the number of organisms capable of growing on agar or gelatine in the various specimens. It must be remembered however that these numbers are true only for the particular tin tested. For example although in D and E, in the case of the tins tested, D came out much worse than E, it does not follow that the results would have been the same if further tins had been tested. The actual number of organisms is of only minor importance, the important point is that none of the milks proved to be sterile.

Nature of Organisms Found on the Agar and Gelatine Plates.

These organisms were chiefly sarcinæ, proteus, spore bearers of the bacillus subtilis group and other micro-organisms which had

no recognisable source in the milk or in human contamination, e.g., a filamentous bacillus, a small gram-positive bacillus and yeasts.

No streptococci or coliform bacilli were found on the plates and the only staphylococcus thus found (H) proved to be probably an air organism.

Streptococci.

Streptococci were demonstrated in all except four specimens. In "B" although they failed to grow in the phenol broth tube inoculated with milk direct from the tin, streptococci were isolated from the lactose bile salt tube, and also from phenol broth inoculated with a sample of "B" which had been incubated at 37° C. for 3 days.

The four specimens from which streptococci were not obtained (F, G, N, O) were the four milks which are put up unsweetened.

Streptococci were successfully isolated from B, C, D, H, I, J, K, L, M, but not from A and E. The modes of isolation were:—

1. By plating out the phenol broth tube on agar. This is the usual method of isolating streptococci, it was successful in B, C, D, K, L, M.
2. By plating out the acidified glucose or lactose bile salt tubes or rebipelagar. This is a somewhat remarkable method, as many streptococci are unable to grow in the presence of bile salts. It is clearly an indication that these streptococci are normally inhabitants of the intestinal tract.

All streptococci isolated were put through the usual tests for identification. The results are set out in Table III. In most cases the organisms isolated from the same milk by two different tests proved identical in their reactions, but in one case (C) variations were shown.

With two exceptions all the streptococci fermented mannite. Those obtained from D (group II.) gave the reactions of the typical streptococcus faecalis. Groups I., III., IV. are all variants of the faecal type of streptococcus. The other two specimens (group V.) did not ferment mannite, but as they grew readily in the cold, clotted milk rapidly and were short-chained they appear to be also variants of the streptococcus faecalis.

Comparing these results with Houston's obtained in streptococci isolated from milk, group V. corresponds with that which Houston obtained most commonly from milk; none of the other groups are found in Houston's series.

These streptococci all differed widely from the varieties that have been isolated from air. They must be put down as of faecal origin, and almost certainly they have all been present in the original milk and have escaped destruction in the process of condensing.

Staphylococci.

An organism was obtained from H which gave the reactions yielded by *sarcina lutea*, and differed from all the ordinary staphylococci in failing to reduce nitrate to nitrite and in rapidly peptonising milk. It was probably an air organism.

Coliform Bacilli.

Although in many cases glucose and lactose bile salt tubes were rendered acid, gas formation did not result in any case.

The simple acidity was due in many cases to the growth of streptococci, and possibly of other organisms.

Gram-negative bacilli resembling the bacillus coli communis were isolated from eight samples (E, F, G, H, K, L, N, O); these were all tested with the usual series of tests. None of these organisms could be properly classified as bacillus coli communis; some (E, F, G) proved to be varieties of Friedländer's bacillus, differing from the bacillus coli communis in being capsulated and fermenting adonite as well as in other essential characters; the others gave none of the reactions for the bacillus coli type.

Anaerobic Spore-bearing Bacilli.

The enteritidis change was not obtained from any specimen of the milk. But clotting of the milk tube due to the presence of an anaerobic spore-bearing bacillus was frequent. This change did not occur in the case of F, G, N, and O, the unsweetened brands.

Conclusions.

None of the specimens of milk tested was sterile. In the case of most, the abundant organisms were such as are abundant in the air, and probably the gross bacterial contamination is derived from the air at some stage in the preparation.

In the case of the four cans of unsweetened milks no organisms were demonstrated that were likely to have existed in the original milk before condensation. In these milks as already stated streptococci and spore-bearing anaerobes were absent. As far as this investigation has gone therefore it seems probable that in the process of condensing unsweetened milk sterility is secured, and that the organisms found in these milks are subsequently introduced from the air.

In the case of all the sweetened milks the streptococci obtained were almost certainly derived from the original milk, and quite possibly the spore-bearing anaerobe was also so derived. But as the enteritidis change was never obtained this latter point cannot be taken as certainly proved. It is evident therefore that in the method of condensing sweetened milk, sterility is not secured, and that organisms present in the original milk do as a rule survive the process of condensation.

The organisms of the bacillus coli communis group are all killed in the process of condensing, either by the heat, or by drying, or by autolysis in the presence of such large quantities of sugar.

The fact that in the three specimens which were incubated at 37° and then examined the number of organisms did not rise, shows that the organisms present are not able to multiply to any great extent in the condensed milk.

TABLE I.

Brand.	(Weight, grammes.)	No. of Colonies on				Streptococci in Phenol. broth.			Fermentation in				Clot or Enteritidis change in Milk.		
		Gelatine plate at 20°.		Agar plate at 37°.		Bile salt Glucose broth.		Bile salt Lactose broth.							
		1/100.	1/1000.	1/100.	1/1000.	1	1/10.	1/100.	1	1/10.	1/100.				
A	Full Cream sweetened	150	21	200	35	+	—	—	—	—	—	—	—	—	—
B ₁	Do.	10	0	8	1	—	—	—	Ac.	—	—	—	—	—	—
B ₂	Do.	1	0	6	1	—	—	—	Ac.	—	—	—	—	—	—
C	Do.	8	0	7	5	—	—	—	Ac.	—	—	—	—	—	—
D	Do.	263	37	175	29	+	—	—	Ac.	Ac.	Ac.	—	—	—	—
E	Do.	9	2	6	0	+	—	—	Ac.	—	—	—	—	—	—
F	Do.	1	1	1	0	+	—	—	Ac.	—	—	—	—	—	—
G	Do.	0	0	4	0	—	—	—	Ac.	—	—	—	—	—	—
H	do. unsweetened	18	1	8	2	+	—	—	Ac.	Ac.	Ac.	—	—	—	—
I	Machine skimmed	8	2	14	3	+	—	—	Ac.	Ac.	Ac.	—	—	—	—
J	Do.	4	0	8	0	+	—	—	Ac.	Ac.	Ac.	—	—	—	—
K	Do.	28	4	11	1	+	+	+	Ac.	Ac.	Ac.	—	—	—	—
L	Do.	37	3	6	1	+	+	+	Ac.	Ac.	Ac.	—	—	—	—
M	Do.	{ several } thou- sands.	{ 244 } over 1000	280½	43	+	—	—	Ac.	Ac.	Ac.	—	—	—	—
N	Full cream unsweet- ened.	{ } over 1000	{ } over 1000	360+	40+	—	—	—	—	—	—	—	—	—	—
O	Do.	1000½	103	130	43+	—	—	—	Ac.	—	—	—	—	—	—
Specimens from same tins tested after incubating 3 days at 37° C.															
B ₃	Full cream sweetened	12	0	{ over- grown }	0	+	—	—	Ac.	—	—	—	—	—	—
C ₂	Do.	6	0	28	0	+	—	—	Ac.	Ac.	Ac.	—	—	—	—
D	Do.	{ very num- erous }	13	70	3	+	—	—	Ac.	Ac.	Ac.	—	—	—	—

TABLE II.

Nature of organisms recognized.

Brand.	Kind of Milk.	Streptococci.	Coli group.	Other gram-negative bacilli.	Proteus.	Spore bearers.	Sarcinae, Yellow.	Staphylococci.	Anaerobic spore bearers not giving enteritidis change.
A	Full Cream ...	+	—	—	+	+	+	—	+
		(not isol.)							
B	Do. ...	+	—	—	+	+	—	—	+
C	Do. ...	+	—	—	+	+	+	—	+
D	Do. ...	+	—	—	—	—	+	—	+
E	Do. ...	+	—	+	—	—	—	—	+
		(not isol.)							
F	Full Cream unsweetened.	—	—	+	—	+	—	—	—
G	Do. ...	—	—	+	—	+	—	—	—
H	Machine skimmed.	+	—	+	—	+	—	+	+
I	Do. ...	+	—	—	—	+	+	—	+
J	Do. ...	+	—	—	—	+	—	—	+
K	Do. ...	+	—	+	+	—	—	—	+
L	Do. ...	+	—	+	—	+	—	—	—
M	Do. ...	+	—	—	—	+	+	—	+
N	Full Cream unsweetened.	—	—	+	—	+	+	—	—
O	Do. ...	—	—	+	—	+	—	—	—

The streptococci (except A and E), the gram negative bacilli, which at first sight resembled the bacillus coli, and the staphylococci were all isolated.

Many other micro-organisms not belonging to any well-known group were also recognized but not examined further.

TABLE III.
Cultural reactions of *Streptococci*.

	Mode of isolation.*	Saccharose.	Lactose.	Raffinose.	Salicin.	Inulin.	Mannite.	Neutral Red.	Milk.		Growth on Gelatine at 20°C.	Length of Chain.
									Acid.	Clot.		
Group I.												
C ₂	P.B.	+	+	—	+	—	+	—	+	+	+	M.
J ₁	L.B.S.	+	+	—	+	—	+	—	+	+	+	B.
I	G.B.S.	+	+	—	+	—	+	—	+	+	+	B.
K ₁	P.B.	+	+	—	+	—	+	—	+	+	+	B.
K ₂	G.B.S.	+	+	—	+	—	+	—	+	+	+	B.
L ₁	P.B.	+	+	—	+	—	+	—	+	+	+	B.
L ₂	G.B.S.	+	+	—	+	—	+	—	+	+	+	B.
M	P.B.	+	+	—	+	—	+	—	+	+	+	B.
Group II.												
D ₁	P.B.	+	+	—	+	—	+	+	+	+	+	B.
D ₂	G.B.S.	+	+	—	+	—	+	+	+	+	+	B.
Group III.												
C ₁	L.B.S.	+	+	—	—	+	+	+	+	+	+	B.
Group IV.												
H	L.B.S.	+	+	—	+	—	+	—	+	+	—	B.
Group V.												
B ₁	P.B.	+	+	—	+	—	—	—	+	+	+	M.
B ₂	L.B.S.	+	+	—	+	—	—	—	+	+	+	M.

* Mode of isolation. P.B. = Phenol broth, plated on agar; L.B.S. = Lactose bile salt broth, plated on rebiipelagar; G.B.S. = Glucose bile salt broth, plated on rebiipelagar.

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R. C. ELMSLIE.

ADDENDUM III.

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